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Across six experiments, I examined the role of metacognitive control in item-method directed forgetting. In Experiment 1, participants studied loud and quiet items, which were subsequently cued as to-be-remembered (TBR) or to-be-forgotten (TBF). Typically, the volume of stimuli does not influence recall, although loud items are judged as more memorable than quiet items (Rhodes & Castel, 2009). In contrast, there was a unique recall advantage for loud TBR items when participants engaged in directed forgetting. Giving participants extra opportunities to engage rehearsal does not produce the selective advantage for loud items (Experiment 2), nor does emphasizing the importance of some items over others (Experiments 3 and 4). Experiment 5 manipulated the encoding fluency of the stimuli using a font type manipulation, which did not produce recall differences between the fluently and less fluently processed items despite the effect of font type on judgments of learning. Finally, Experiment 6 investigated participants' beliefs about what helps them disengage from TBF items and what helps them retain TBR items. Specifically, after TBF or TBR items, participants were told to select earlier studied line drawings that varied both in perceptual size (small vs. large size image) and conceptual size (drawing of a small vs. large object in real life). I propose two mechanisms to explain the results. According to the rehearsal strategy mechanism, people use beliefs about item memorability to selectively rehearse certain items as a way to forget other items. According to the salience mechanism, people are drawn to perceptually salient stimuli when performing directed forgetting.

BELIEFS ABOUT ITEM MEMORABILITY AFFECT METACOGNITIVE CONTROL IN ITEM-METHOD DIRECTED FORGETTING

by

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Performance in many memory experiments is governed by the goal of retaining information for a future memory test. The ability to determine how well one has learned something and to use that information to inform future study decisions is a crucial part of an adaptive memory system (e.g., Dunlosky & Bjork, 2008; Metcalfe & Finn, 2008; Nelson & Narens, 1990; Son & Metcalfe, 2000). A wealth of research on study time allocation examined how people regulate their remembering by analyzing either the length of time people spend studying items, or examining which items people chose to re-study again in a second study session (see Metcalfe & Kornell, 2005; Son & Kornell, 2008). Many theories explain how people regulate their *remembering*. The discrepancy reduction account proposes that, after studying a list of items, participants are more likely to want to restudy items that they think will be the most difficult to learn (Dunlosky & Hertzog, 1998; Dunlosky & Thiede, 2004; Mazzoni & Cornoldi, 1993; Thiede, 1999; Thiede & Dunlosky, 1999). The region of proximal learning model (Kornell & Metcalfe, 2006; Metcalfe & Kornell, 2005; Son & Metcalfe, 2000) states that difficult items are more likely to be restudied if they are in a list with other easy items because people think they do not need to spend time any more time studying the easy items. However, if the list is composed of moderately difficult to very difficult items, then according to the region of proximal learning account people will select to restudy the moderately difficult items because they will perceive the very difficult items as impossible to learn. Finally, the agenda-based model of regulation proposes that whether participants select to restudy easy or difficult items may depend or constraints imposed by the task, like how valuable some items are compared to others (Ariel, Dunlosky, & Bailey, 2009).

Similar to research on regulation of learning, there has been a wealth of research examining how people exert control over *forgetting*. One such phenomenon that received extensive attention is directed forgetting, which typically shows that people can make themselves forget recently-learned information when instructed by an experimenter (e.g., Bjork, LeBerge, & Lagrand, 1968). Directed forgetting has been studied with a variety of stimuli, under many conditions of traditional memory paradigms of cognitive psychology, in different settings including clinical, social, and legal environments, both with humans and with animals (for an integrative review, see the edited volume by Golding and MacLeod, 1998). Despite nearly four decades of research on this topic, the examination of metacognitive factors in directed forgetting is in its infancy. Recently, Friedman and Castel (2011) examined the role of *monitoring* in directed forgetting, and showed that people estimate that they will be less likely to remember an item following an instruction to forget compared to an instruction to remember that item, suggesting that they are aware of the detrimental effect of a forget cue. I suspect that not only can people monitor the consequences of the forget cue, but that they also engage monitoring and *control* processes when they attempt the directed forgetting task, including determining whether or not to engage in directed forgetting in the first place. Forgetting deserves to be examined as a process separate from remembering (or failures of remembering) because framing instructions in terms of forgetting influences the way people approach a metacognitive judgment task (Finn, 2008; Koriat, Bjork, Sheffer, Bar, 2004). Thus, metacognition research may be overlooking important mechanisms if it focused strictly on remembering, or if it treated forgetting as the opposite of remembering.

Directed forgetting is one form of forgetting, but unlike unintentional forgetting that happens most of the time without much conscious control, directed forgetting requires the engagement of control mechanisms. In this paper, I approach the directed forgetting task from the metacognitive framework of monitoring and control (e.g., Koriat, 2007; Koriat & Goldsmith, 1996; Nelson & Narens, 1990, 1994). I focus primarily on the item-method directed forgetting procedure, whereby participants are shown a series of items that are subsequently cued as to-be-remembered (TBR) or to-be-forgotten (TBF) on an item-by-item basis. This procedure produces a memory impairment of TBF items in recall and recognition tests, as well as implicit memory tests (for reviews, see E. L. Bjork, Bjork, & Anderson, 1998; Basden & Basden, 1998; MacLeod, 1998). It is generally agreed upon that directed forgetting in the item-method arises from processes operating during encoding (Basden, Basden, & Gargano, 1993; Bjork & Woodward, 1973; MacLeod, 1999; Taylor, 2005; Woodward & Bjork, 1971). When an item is presented, participants start to rehearse that item and they will continue to rehearse it if a TBR cue follows it, but they will stop rehearsing the item if a TBF cue follows it. Thus forgetting arises from terminating the rehearsal of TBF items. Some researchers have recently challenged this passive view of directed forgetting and have proposed that the actual process of stopping rehearsal of TBF items involves the recruitment of inhibitory mechanisms (Fawcett & Taylor 2008; 2010; Hourihan & Taylor, 2006; Taylor, 2005; see also Zacks, Radvansky, & Hasher, 1996). For example, following the TBF cues, participants are slower to detect a secondary visual or auditory probe (e.g., Fawcett & Taylor 2008; 2010), and they show a larger inhibition of return after the TBF cues (e.g., Fawcett & Taylor, 2010; Taylor, 2005), suggesting that active attentional mechanisms are recruited in item-method directed forgetting. Consistent with this claim, neuroimaging work has shown that intentional forgetting relies on a distinct network of brain regions compared to the forgetting that occurs simply from a lack of remembering (Wylie, Fox, & Taylor, 2007; see also Ullsperger, Mecklinger, & Muller, 2000).

Regardless of the mechanism responsible for item-method directed forgetting, I approach this task by considering the importance of two different goals that it simultaneously invokes – remembering of TBR items and forgetting of TBF items. I suggest that how people accomplish those two goals likely involves metacognitive processes. To accomplish the *goal of remembering* TBR items, people may use the TBF trials as an opportunity to engage in further processing of TBR items, and they do so for the sake of enhancing their memory of TBR items later on during the test. Examining which items people select to rehearse during the TBF trials could be informative for understanding control processes aimed at remembering. For example, will people be more likely to rehearse the items they believe are less memorable and therefore require additional rehearsal, or will they be more likely to rehearse the items that they believe are more memorable because they think they will gain more by focusing their effort and energy on already memorable items? Thus, the process of deciding which TBR items to rehearse during the TBF trials shares conceptual similarities with the study-time allocation decisions, and therefore the models of self-regulation of learning might explain how people allocate their rehearsal in order to accomplish the goal of remembering TBR items.

In contrast, to accomplish the *goal of forgetting* TBF items, people may engage in selective rehearsal of other items during the TBF trials out of a desire to distract themselves from the item they are trying to forget. In other words, they may be rehearsing earlier TBR items during the TBF trials for the sake of ensuring the forgetting of the items they are told to forget (rather than for the sake of remembering those TBR items). This would imply that people engage in controlled process aimed at forgetting, and the type of items they select to distract themselves during the TBF trials could be influenced by metacognitive beliefs regarding which items are better "blockers" of unwanted information.

Thus, the process of selective rehearsal invoked by the directed forgetting procedure can be serving two different goals, which may be influenced by different metacognitive biases and beliefs. Behaviorally, however, this may lead to a distinction without a difference because examining performance only in the directed forgetting group makes it difficult to disentangle the remembering component from the forgetting component, making it impossible to evaluate which goal was affected by metacognitive influences. Sahakyan and Foster (2009) recommended including a baseline group in the experiment, where all items are followed by TBR cues, and therefore performance in this condition could only be governed by the remembering goal. Comparing the directed forgetting group and the baseline group would allow isolating the metacognitive influences on the forgetting goal separately from the remembering goal.

In addition to the control processes involved in directed forgetting task, how well people monitor the status of their memory during the experiment could in turn influence how they exert control in directed forgetting. There is recent evidence showing reduced judgments of the likelihood of later recall (i.e., judgments of learning or “JOLs”) following TBF trials compared to TBR trials, suggesting metacognitive sensitivity in the item method (Friedman & Castel, 2011). However, if participants feel that they have not learned an item they are told to forget, they may be less likely to engage in directed forgetting because they do not think they will remember it to begin with. Thus, the degree to which people’s monitoring captures how well they have mastered the information should have implications for directed forgetting performance.

One approach to implicating the role of metacognitive factors in directed forgetting is to find manipulations that affect people’s beliefs about memory, without objectively influencing memory. If greater directed forgetting is obtained in some conditions than in others, it could be directly traced to metamemory rather than objective memory differences. Rhodes and Castel (2009) had participants study a mixed list of items presented in loud and quiet volumes. Although people rated loud items as more memorable than quiet items by assigning them higher JOLs, they recalled both types of items equally well. Importantly, the mechanisms driving this illusion were shown to have an effect on control processes by influencing participants’ future study decisions. When asked to select which items participants wished they could re-study, they were more likely to select quiet items than loud items.

Overview of the Current Experiments

This manuscript consists of two major sections. It reports six experiments, where the first four experiments establish that beliefs about item memorability influence how people perform an intentional forgetting task. The last two experiments, along with the interim analyses of the verbal reports and the output dynamics aim to test the theoretical mechanisms contributing to the effects observed in the previous experiments. More specifically, in Experiment 1, participants were exposed to a mixture of loud and quiet items, which were subsequently cued as TBR or TBF items. In the baseline group, all items received TBR cues. To preview the results, the directed forgetting group showed the same magnitude of impairment for both quiet and loud TBF items relative to the baseline group, indicating no difference in recall of loud and quiet TBF items. Importantly, the directed forgetting group remembered a greater proportion of loud and quiet TBR items compared to the baseline group, but the enhancement was larger for loud TBR items. This finding implies that directed forgetting group selectively rehearsed earlier presented loud TBR items to a greater extent than quiet TBR items. In Experiment 2, I aimed to examine whether loud TBR items were rehearsed more because participants were using it as a strategy aimed at forgetting TBF items, or whether participants were simply rehearsing loud TBR items because they thought those items were more memorable and hence by focusing rehearsal on more memorable items they could enhance their overall recall performance later on. In Experiment 2, I eliminated all TBF trials, and included additional trials during which participants could engage in extra rehearsal of earlier presented items. The results showed that when the forgetting trials were eliminated from the task, participants did not spontaneously rehearse loud items (unless specifically instructed to rehearse those items). Experiments 3 and 4 further established that the forgetting goal was critical for observing the loud item advantage. Specifically, loud and quiet items were assigned either graded positive values, or a combination of positive and negative values. The results of both experiments revealed that the loud item advantage emerged only in the context of forgetting – that is, when some items were assigned negative point values. Overall, the first four experiments established that when participants aim to intentionally forget some items, they tend to focus their rehearsal processes on those items that they think are more memorable (i.e., loud items). Thus, Experiments 1–4 provide the first empirical evidence that beliefs about item memorability influence how people attempt directed forgetting.

Next, I present the analyses of the output dynamics along with analyses of verbal reports collected in Experiments 1–4. In Experiment 5, I tested the *fluency hypothesis* according to which a directed forgetting task may lead participants to focus their rehearsal on more fluently processed items. Participants performed directed forgetting on a list of easy-to-read (Arial font) items intermixed with difficult-to-read (Brush font) items. Finally, in Experiment 6, I tested the *salience hypothesis* according to which participants may select to distract themselves with more salient items in order to accomplish directed forgetting. Participants were shown a list of drawings that varied in perceptual size as well as in conceptual size, and were asked to provide JOLs for those drawings. Later, they engaged in directed forgetting of unrelated words, and a subset of earlier drawings was presented either after TBR or TBF cues. Participants were told to select a drawing that they think will help them remember or forget the recently presented word.

CHAPTER II

EXPERIMENT 1

The purpose of Experiment 1 was to explore how a volume manipulation affects the directed forgetting task versus the remembering-only task. Although loud and quiet items should be remembered equally well when the instructions mainly emphasize remembering (e.g., Rhodes & Castel, 2009), instructions to forget may affect TBR and TBF items differently depending on the mechanism underlying item-method directed forgetting and how metacognition interacts with this mechanism. If forgetting arises from a passive process of stopping rehearsal, loud and quiet TBF items should suffer equally. At the same time, recall of loud and quiet TBR items should not be different because people should be rehearsing them equally, just like in a remembering-only task. If an active inhibitory mechanism targets individual items in directed forgetting, then loud TBF items might be forgotten more because they are perceived to be more memorable and thus might require more inhibitory efforts. In this case, recall of loud and quiet TBR items should be equal because the inhibitory mechanism will operate on loud TBF items only. Finally, a third possibility is that participants engage in an active forgetting process, but they do so by focusing rehearsal on the TBR items that they believe are more memorable as a strategy aimed at preventing encoding of TBF items. This should produce enhanced memory for loud TBR items compared to quiet TBR items because participants may select to devote their rehearsal to items they believe are more memorable (i.e., loud TBR items) as a way of preventing encoding of TBF items. Recall of TBF items, however, should remain unaffected by volume because rehearsal will be focusing on loud TBR items only.

Method

Participants

Participants were 96 UNCG undergraduates who participated for course credit.

Materials and Design

The study list consisted of 32 medium frequency unrelated nouns (see Table 1). Each item was assigned equally often to the TBF and TBR cue. It was also presented equally often in a quiet volume and in a loud volume. During the presentation, items within each list were randomized with the constraint that no more than three cues of the same type and no more than three items of the same volume could follow in a row.

List items were recorded using Audacity (http://audacity.sourceforge.net/). Each item was recorded once and then two versions of each recording were created – a quiet version and a loud version. Each quiet item produced 50 dBs of sound (e.g., a word spoken across a room), whereas each loud version produced 55 dBs of sound (e.g., a word spoken in at point blank). The 5 dB increase is equivalent to an increase in the power ratio by a factor of 3.16, and it follows the 3-factor increase in volume reported by Rhodes and Castel (2009).

The design of the directed forgetting (DF) group involved a Volume (quiet vs. loud) by Cue (TBF vs. TBR) repeated-measures design. In addition to the DF group, I also included a baseline group in which all quiet and loud words were followed by TBR cues (there were no TBF cues). The dependent measure of interest was the proportion of items correctly recalled, although I also collected and analyzed immediate JOLs. The primary reason for including the JOL stage was to ensure I replicate the findings of Rhodes and Castel (2009); however, the main goals concerned evaluating how the volume manipulation would influence recall.

Procedure

Participants were told they would be presented with a list of words to study for a later memory test. Before the study session, however, they listened to a practice trial of a single nonword spoken at the quiet and loud volumes. The volume levels were preset and adjustments were made if a participant reported difficulty with hearing the quiet nonword. No participant reported difficulty hearing the quiet practice item. Participants then studied a list of 32 words presented over headphones at a rate of 5 s per word. A speaker icon appeared on the monitor for the entire 5 s to signify the study trial. Participants were then instructed to provide a JOL by indicating how likely they would be to recall that word later on, using a scale from 0 (*not likely at all that I will remember the word*) to 100 (*very likely that I will remember the word*). Participants were given 3 s to type each JOL into the computer and they were encouraged to use the entire range of the scale. The JOL entry appeared on the screen as it was entered and could be edited if a mistake was made. Next, a TBR or TBF cue appeared for 4 s. The TBR cues appeared in green-colored font and had two plus signs on either side of the word, whereas the TBF cues were in red-colored font and were flanked by two minus signs. Sixteen items were followed by TBR cues while the remaining sixteen were followed by TBF cues.

Participants were told from the outset of the experiment that their memory would be later tested only for TBR items, but that they would not be tested for TBF items and that they could forget those words. Each item-JOL-cue trial was separated by a 1 s inter-stimulus interval.

A baseline group was included that followed the exact same procedures as the DF group, except that they never received the TBF cues. Like the DF group, the baseline group was told upfront that each word would receive either a TBR or TBF cue. In reality, however, only TBR cues followed each item's JOL trial.

After the study phase, participants engaged in a distractor task for 60 s, which involved writing down the names of as many United States that they could think of. Finally, a free recall test was administered in which participants were given 4 minutes to write down as many words from the list that they could remember. Participants were told to recall *all* studied words, including the ones they were told to forget. After recall, participants completed a brief post-experimental questionnaire designed to assess learning strategies, intentional forgetting strategies, and whether participants had a preference for rehearsing items of a certain volume. The two critical questions that I will analyze in this paper were the following: (1) "*What did you do during the time the forget cue (the word "forget" with the minus signs) was on the screen*?" and (2) "*Did you try to remember (a) loud words more than quiet words, (b) quiet more than loud, or (c) did you try to remember the loud and quiet words to about the same extent*?"

Results & Discussion

Recall. The proportion of words recalled for the baseline and DF groups across the volume and cue are displayed in Figure 1. Replicating Rhodes and Castel (2009), there was no difference in recall of loud and quiet items in the baseline group, $t<1$.

To completely evaluate directed forgetting in the item-method directed forgetting design, I assessed the degree to which the TBF items suffered and the TBR items benefitted compared to an all-remember baseline group (see also, Sahakyan & Foster, 2009). I assessed these effects by comparing each item type in the DF group to the baseline group.

A mixed ANOVA on TBR items, using Volume (quiet vs. loud) as the within-subjects factor and Group (DF vs. baseline) as the between-subjects factor revealed that the DF group had greater recall (M=.47, SD=.15) than the baseline group (M=.32, SD=.15), $F(1,94)=24.59$, MSE=.045, $p<.001$. Additionally, there was a main effect of volume, ($F(1,94)=10.06$, MSE=.016, $p<.01$), with better recall of loud items (M=.42, SD=.10) than quiet items (M=.36, SD=.19). Interestingly, there was a significant interaction, $F(1,94)=4.18$, MSE=.016, $p<.05$. Loud TBR items were recalled significantly better than quiet TBR items in the DF group [($t(47)=3.29$, $p < .01$], but there was no difference between the loud and quiet items in the baseline group, $t<1$. Therefore, compared to the baseline group, there was greater enhancement for loud TBR items (19%) than for quiet TBR items (11%) in the DF group.

I conducted similar analyses on TBF items to analyze the magnitude of directed forgetting impairment. The Volume (quiet vs. loud) x Group (DF vs. baseline) ANOVA on TBF items revealed that the DF group showed impaired recall of TBF items (M=.19, SD=.10) compared to the baseline group (M=.32, SD=.15), $F(1,94)=25.85$, MSE=.031, $p<.001$, for the main effect of group. The main effect of volume was not significant, $F<1$, and neither was the volume by group interaction, $F(1,94)=1.03$, p=.31, suggesting that the magnitude of impairment was the same for the loud and quiet items.

JOLs. Table 2 shows the JOL values for quiet and loud items across DF and baseline conditions. Because TBR and TBF cues were presented *after* each JOL trial, they could not have influenced JOLs, and therefore I left the Cue factor out of the analysis. I included group as a factor in the analyses because the mere presence of the TBF and TBR cues may have changed the basis of JOLs and could have influenced the magnitude of the JOL effect compared to the baseline group. A Volume (quiet vs. loud) by Group (DF vs. baseline) mixed ANOVA on JOLs revealed only a significant effect of volume, $F(1,94)=53.65$, MSE=104.20, $p<.001$. Loud items received higher JOLs (M=63.02, SD=16.41) than quiet items (M=52.23, SD=18.35). The effect of Group was not significant, $F(1,94)=2.63$, p=.11, and neither was the interaction, $F<1$. Thus, loud items were judged as being more memorable than quiet items, replicating the findings of Rhodes and Castel (2009), and this finding was unaffected by whether participants received a mixture of TBR and TBF cues, or if they only received TBR cues.

Discussion. The baseline group remembered quiet and loud words equally well, replicating Rhodes and Castel (2009). In contrast, volume influenced recall in the DF group in unique ways. Although the recall of TBF items in the DF group suffered compared to the recall in the baseline group, quiet and loud items suffered to the same extent from directed forgetting. In contrast, whereas the recall of TBR items in the DF group was enhanced compared to the baseline group, loud TBR items were remembered better than quiet TBR items. Equivalent impairment of quiet and loud TBF items seems to suggest that either forgetting was caused by simply ignoring all TBF items, or by engaging some active mechanism via rehearsing loud TBR items, which helped facilitate the forgetting of TBF items. I come back to the distinction between “ignoring to forget” and “actively rehearsing to forget” in Experiment 4.

The volume effect in TBR items in the DF group suggests two possibilities. Perhaps participants were using the TBF trials to selectively rehearse loud TBR items because they thought that loud items were easier to remember, and they therefore selected to devote their rehearsal to easy items (Dunlosky & Thiede, 2004; Nelson & Leonesio, 1988; Son & Metcalfe, 2000). Thus the presence of TBF trials simply enabled them to engage in additional rehearsal. This implies that selective rehearsal of loud items was used as a strategy *aimed at remembering* as many TBR items as possible during the later test. Alternatively, participants in the DF group may have selected to rehearse loud items to a greater extent because they might have perceived loud items are better “blockers” of unwanted information. In other words, they engaged in selective rehearsal of loud items as a strategy *aimed at forgetting* TBF items. Experiment 2 was conducted to examine these hypotheses.

CHAPTER III

EXPERIMENT 2

If participants in the DF group engaged in selective rehearsal of loud items as a strategy aimed at remembering as many TBR items as possible, then why did I fail to observe a similar effect in the baseline group, which contained only TBR trials? The absence of this effect in the baseline group suggests that engaging in intentional forgetting is critical to producing a loud item advantage. However, the baseline group had twice as many items to keep in mind compared to the DF group, which could use the TBF trials as an opportunity to rehearse earlier TBR items. Thus, it is possible that the observed effects in the DF group may have had nothing to do with intentional forgetting per se and may have been driven by the goal to remember as many TBR items as possible (just like in the baseline group); however, conditions for additional rehearsal may have been more ripe in the DF group.

If engaging in intentional forgetting is not critical in producing the loud item advantage, then I should observe a similar effect if I reduce the number of items participants had to remember for a later test, while also creating opportunities for additional rehearsal during study. Therefore, in Experiment 2, all TBF trials were replaced with an irrelevant task that did not involve memorizing. Participants were exposed to 16 TBR trials intermixed with 16 visual search trials (i.e., there was no directed forgetting manipulation in this experiment).

There were four groups, which differed with respect to the type of rehearsal instruction they received at the start of the experiment. The *no-instruction* group was not given any rehearsal instructions in order to evaluate if, in the absence of TBF trials, people would spontaneously choose to rehearse loud items provided they had opportunities to engage in additional rehearsal. Observing loud item advantage in the *no-instruction* group would confirm that intentional forgetting is not critical in producing this effect.

The second group was instructed to strategically rehearse those words that they think would improve their memory performance later (termed *extra-rehearsal* group). No mention was made regarding which type of items they should rehearse. The *extra-rehearsal* group would provide even a stronger test of whether intentional forgetting is critical in producing loud item advantage. This group is meant to simulate the DF group because it is told to engage in rehearsal of earlier items without being told which items to rehearse; the main difference is that it has no TBF trials. If participants elect to rehearse loud items more, then I should see a loud item advantage in the *extra-rehearsal* group. Note that I might actually observe a quiet item advantage, implying that participants prefer to devote their rehearsal to more difficult items (e.g., quiet items). This prediction follows the results of Rhodes & Castel (2009) who found that participants indicated a preference to re-study quiet items more than loud items if given an opportunity to re-study.

The third group was told to rehearse the loud items during spare time in the experiment to see if people could actually distinguish between loud and quiet words during rehearsal (termed *rehearse-loud* group). I expected to observe loud item advantage in this group, pending people could differentiate between the two types of items during rehearsal. Finally, the fourth group was told to rehearse quiet items during spare time in the experiment (termed *rehearse-quiet* group). If I observe a quiet item advantage in this group, it would imply that participants could have selectively rehearsed quiet items in the DF group of Experiment 1 if they wanted to. However, it is possible that even if participants are told to rehearse quiet items, they might not be able to rehearse them as effectively because during rehearsal, loud items might come to mind more fluently than quiet items, making it more difficult to rehearse the quiet items. Thus, the rehearse-quiet group might not show a quiet item advantage, and such findings would constrain the interpretations of directed forgetting effect obtained in Experiment 1.

Method

Participants

There were 128 UNCG undergraduates who participated for course credit. None of these participants had been in the previous studies.

Materials

The materials were the same as in the prior experiments. The most important change involved replacing the TBF trials from the previous experiments with a visual search task that involved a conjunction search of colors and shapes. During the visual search trials, participants were shown a 6 x 6 matrix of 35 distractors and a single target item. The distractors consisted of a mixture of blue squares and red triangles, whereas the target was a red square. Participants were told to click on the red square as soon as they located it amidst the distractors. The arrangement of distractors and the position of the target among the distractors were randomized for each participant.

Procedure

Participants were told that they would hear words through their headphones and that they should attempt to remember them for a later memory test. Additionally, they were told that on some trials, they would not hear any words but would instead perform a visual search task. Two practice trials familiarized participants with the steps and procedures of the experiment.

At the start of the experiment some participants were told that whenever they had spare time during the experiment, they should engage in one of the following activities. Participants in the extra-rehearsal condition were told to "*strategically rehearse those specific words presented earlier that you think will increase the number of words you will remember during the test*". Participants in the rehearse-loud-items condition were told to "*think back to the loud words that you heard from earlier and rehearse to yourself those loud items*". Participants in the rehearse-quiet-items condition were told the same thing except that any mention of loud items in the instruction was replaced with quiet items. Finally, the no-instruction condition was simply told that there may be spare time between the trials and that they should get ready for the next trial.

The presentation order of word trials and visual search trials was randomized with the constraint that no more than three presentations of each trial type (word vs. visual search), and no more than two presentations of each item type (loud vs. quiet) occurred in a row. During the *word trials*, a loud or a quiet word was presented via headphone at a rate of 5 s following the procedures described in Experiment 1. Afterwards participants were given 3 s to type in their JOL response. A 4 s blank interval followed the JOL trials (in lieu of the TBR cue) to facilitate potential additional rehearsal. During the *visual search trials*, a matrix of shapes was presented for 5 s, and participants had to identify and click on the target. Following each visual search trial, just like in the word-trials, there was a 4 s blank interval to facilitate potential additional rehearsal. After all 32 trials, participants engaged in the same filler task and free recall tasks as those described in Experiment 1.

Finally, participants in the *no-instruction* group were asked: (1) "*After studying each word, you made a judgment about it and then there was a blank screen for about 4 seconds. What did you do during the period when the screen was blank?*" In addition, both the *no-instruction* group and the *extra-rehearsal* group was given the second question from the questionnaire (2) "*Did you try to remember (a) loud words more than quiet words, (b) quiet more than loud, or (c) did you try to remember the loud and quiet words to about the same extent*?"

Design

The design involved a Volume (quiet vs. loud) by Instruction (rehearse-loud vs. rehearse-quiet vs. extra-rehearsal vs. no instruction) mixed factorial, where volume was varied within-subjects and instruction was varied between-subjects.

Results & Discussion

Recall. A volume (quiet vs. loud) by instruction (no-instruction, extra-rehearsal, rehearse-loud, rehearse-quiet) mixed-factorial ANOVA was performed on recall. The results are summarized in Figure 2. Neither the main effect of instruction ($F(1,124)=1.17$, $MSE=.048$, $p=.33$), nor the main effect of volume were significant, $F(1,124)=2.46$, $MSE=.038$, $p=.12$. However, there was a significant volume by instruction interaction, $F(3,124)=13.05$, $MSE=.038$, $p<.001$. Comparing the recall of loud and quiet items in each of the four conditions revealed that there was no difference in the no-instruction condition ($t<1$), indicating that although participants had opportunities to go back and rehearse earlier presented items, they did not show any preference for either type of item. The same pattern emerged also in the extra-rehearsal group, where the recall of loud and quiet items was equivalent, $t<1$. Although this group was instructed to rehearse earlier presented items during the spare time, it showed a 7% recall advantage compared to the no-instruction group (collapsed across volume), but the improvement was not statistically significant ($p=.11$). Because there was no significant difference in overall recall between the no-instruction group and the extra-rehearsal group, it suggests that the no-instruction group was most likely already rehearsing items during the spare time in the experiment even without being explicitly prompted to do so. Indeed, the verbal reports from the no-instruction condition revealed that 66% of the participants indicated rehearsing earlier presented items during the blank periods of the experiment (in response to the first question of the post-experimental questionnaire). In response to the second question of the questionnaire, only 6% of participants in the extra-rehearsal group reported preferring to rehearse loud items, with 13% reporting preference for quiet items, and the majority of participants (81%) reporting having “no preference for any type of item”, $X^2(2, N=32)=33.25$, $p<.001$. These findings are informative because they suggest that people did not interpret the instruction to "rehearse the words that you think will help you remember the most" as an instruction recommending rehearsal of loud items. Because a large majority of people had no volume preference, it suggests that people do not choose to rehearse loud items as a way to help them remember the most.

In contrast to the no-instruction group and the extra-rehearsal group, the remaining two groups showed advantage of those specific items that they were instructed to rehearse. Specifically, loud items were recalled better than quiet items in the rehearse-loud condition, $t(31)=5.25$, $p<.001$, whereas quiet items were recalled better than loud items in the rehearse-quiet condition, $t(31)=2.64$, $p<.05$. Furthermore, in the rehearse-loud condition, loud item recall was significantly enhanced compared to the no-instruction group ($t(62)=3.37$, $p<.01$), whereas the recall of quiet items went down numerically compared to the no-instruction group, although this effect was not significant ($t(62)=1.79$, $p<.08$). Instructions to rehearse loud items may have led participants to somewhat neglect the quiet items during encoding, and there may have been a tendency to rehearse loud items at the expense of quiet items. However, caution is warranted with this conclusion because the decline in quiet item recall was not statistically significant. Finally, in the rehearse-quiet condition, quiet item recall was significantly enhanced compared to the no-instruction condition ($t(32)=2.50$, $p<.05$), whereas loud item recall did not suffer ($t<1$). This effect suggests that participants benefited from rehearsing quiet items, and that this did not come at the expense of loud items.

JOLs. A Volume by Instruction mixed-factorial ANOVA was conducted on JOLs. The results are shown in Table 2. There was a significant volume by instruction interaction, $F(3,124)=8.65$, $p<.001$. Separate comparisons of quiet versus loud JOLs in each instruction group revealed that the extra-rehearsal group gave higher JOLs for loud items than quiet items ($t(31)=3.60$, $p<.01$), as did the rehearse-loud group ($t(31)=5.36$, $p<.001$), and the no-instruction group, $t(31)=3.00$, $p<.01$. The only group that did not show this effect was the rehearse-quiet group ($t<1$), which rated the loud and quiet items as equally memorable. The lack of the volume effect in the rehearse-quiet group is more meaningful in light of the magnitude of the same effect in the rehearse-loud group (20%), which was substantially larger than in the no-instruction group (6%) and the extra-rehearsal group (8%). Thus, an instruction to rehearse loud items enhanced the volume effect, whereas instructions to rehearse quiet items eliminated this effect.

Discussion. Overall, the recall findings suggest that loud items have a recall advantage only when participants were explicitly told to rehearse the loud items. However, when left to their own devices, participants did not spontaneously engage in rehearsal of loud items. Furthermore, even when they were instructed to engage in extra rehearsal without specifying which type of items to rehearse, they still did not prefer to rehearse loud items. Interestingly, the rehearse-quiet group showed enhanced memory for quiet items suggesting that participants' ability to rehearse quiet items was not thwarted by the fluency of loud items. Therefore, if participants wanted to rehearse quiet items during spare time, they could have done so in the remaining conditions. However, I never observed a quiet item advantage without specifically instructing participants to rehearse quiet items.

The JOL findings, with an exception of the rehearse-quiet group, all showed that participants thought that loud items would be remembered better than quiet items, replicating Rhodes and Castel (2009). Upon closer inspection, the volume effect in the rehearse-loud condition was greater than in the other conditions suggesting that instructing participants to rehearse loud items had a reactive effect on their JOLs. Both loud and quiet items JOLs were affected by the rehearse-loud instruction, with loud items being judged as more memorable, while quiet items being judged as less memorable compared to the no-instruction condition. In contrast, the rehearse-quiet condition rated the two types of items as equally memorable, and this was driven by the decrease of loud item JOLs while quiet item JOLs were unaffected compared to the no-instruction group. This implies that the perception that loud items are more memorable is so robust that even the instruction to rehearse-quiet items cannot reverse this effect in favor of quiet items; it can at most eliminate it, but not reverse it. Although JOLs were not the primary focus of investigation, the finding that the volume effect can be influenced by experimental instructions is intriguing and deserves to be examined in future research.

Overall, the results of Experiment 2 suggest that providing participants with extra rehearsal opportunities is not sufficient to produce a memory advantage for any type of item without directly instructing participants to rehearse either loud items or quiet items. This implies that when participants only have the goal to remember items (without the competing forgetting goal), they do not spontaneously rehearse loud items to a greater extent than quiet items even when opportunities to engage in rehearsal are created throughout the experiment.

CHAPTER IV

EXPERIMENT 3

The results of the experiments presented thus far suggest that the forgetting component is important for producing the loud item advantage (Experiment 1) aside from explicitly instructing participants to rehearse loud items (Experiment 2). In Experiment 3, I aimed to rule out an additional alternative interpretation of the data that does not require an intentional forgetting component. Specifically, directed forgetting cues may stress the importance of some items over others, with participants perceiving TBR items as more important than TBF items. If this is the case, then they may adopt a rehearsal strategy that capitalizes on metacognitive cues, like volume, in order to help them perform the task of remembering the more important items. That is, people might rehearse loud volume items not as a way to perform intentional forgetting per se, but as a way to help them focus on items that they believe to be more important, like TBR items. Therefore, I might observe a memory advantage for loud items even in a list where some items are deemed as more important than others without involving directed forgetting cues.

In Experiment 3, all TBR and TBF cues were replaced with point values, and participants were told that they would earn or lose points by remembering words. Half of the participants received only positive value points (+5 and +10), where +10 words signified the “more important” words and +5 words signified the “less important” words. This condition will be referred to as the *prioritized remembering* group because the goal of this group is only to *remember* the words, but some words are more important than others because they are worth more points. The point value manipulation was crossed with the volume manipulation. If importance is the critical variable driving the loud item advantage, then +10 loud words should be better recalled than +10 quiet words in the prioritized remembering group. This is because +10 items are more important items than the +5 items, and participants may selectively rehearse the loud important words to a greater extent.

The remaining half of the participants were assigned to the *forgetting* group, where they received a mixture of positive and negative value points (-5 and +10) crossed with volume manipulation. The +10 words in this condition signified the "more important" words, but -5 words were not merely "less important", they were actually detrimental to performance. Thus, participants would be better off forgetting the -5 words and remembering only +10 words, even though they were never explicitly told to forget the -5 point words. Functionally, the forgetting group in the current experiment resembles the DF groups employed in Experiment 1, with -5 items being analogous to TBF items, and +10 items being analogous to TBR items. Therefore, I expected to obtain higher recall of +10 loud words over +10 quiet words in the forgetting group, similar to what I observed in Experiment 1. The critical predictions concern whether this effect should emerge only in the forgetting group, or whether it would emerge also in the prioritized remembering group. If importance is the critical variable driving this effect and intentional forgetting is irrelevant, then +10 loud words should be better recalled than +10 quiet words in both groups. In contrast, if having to engage in intentional forgetting is critical, then +10 loud words should be better recalled than +10 quiet words only in the forgetting group, and there should be no such effect in the prioritized remembering group.

Method

Participants

Participants were 64 UNCG undergraduates who participated for course credit. None of them had participated in previous experiments.

Materials

The materials were the same as in the prior experiments. Items were rotated through the different volume and value conditions. Presentation order of items was randomized with the constraint that no more than three items of the same volume occurred in a row, and no more than three values of the same type appeared in a row.

Procedure

The procedure was very similar to Experiment 1, except that instead of TBR/TBF cues, participants saw value points. They first studied items through headphones for 5 s and then performed a JOL for that word for 3 s. They were told that after making a JOL, a number would appear indicating how many points that word is worth if it is recalled during the test. Participants in the prioritized remembering group were told that, during study, words would receive point values of +5 and +10. Recalling a +5 word later on would add 5 points to their score, and recalling a +10 word would add 10 points to their score. Participants in the forgetting group were told the same thing about the +10 words. However, they were also told that some words would be followed by a -5 value cue and that if these words were recalled later on, 5 points would be subtracted from their final score. None of the participants in the forgetting group were explicitly told to forget -5 words. It was made clear to all participants that their goal was to earn as many points during the test as possible. Two practice trials familiarized participants with the steps and procedures of the experiment.

After studying the list, participants engaged in the same distractor and free recall tasks used in prior experiments. Importantly, before the test, the experimenter unexpectedly canceled the implications of point values (as is often done in directed forgetting procedure). All participants were told that every item would be worth +10 points and that they should try and recall all items regardless of the original value assigned to that item.

Finally, the post-experimental questionnaire was administered. All participants were asked: (1) "*What would you do when the +10 values would appear on the screen?*", (2) "*What would you do when the -5 (or +5) values appeared on the screen?*" and (3) "*Did you try to remember (a) loud words more than quiet words, (b) quiet more than loud, or (c) did you try to remember the loud and quiet words to about the same extent?*".

Results & Discussion

Recall. The recall was analyzed following the same format as in Experiment 1. My critical predictions concerned the recall of +10 items (i.e., important items) across the forgetting group and prioritized remembering group, and therefore I focus my analyses on these items first. This analysis is functionally equivalent to the analyses on TBR items performed in Experiment 1. Critical for my hypothesis is whether I would obtain a recall advantage for +10 loud words over +10 quiet words in the forgetting group only, or whether a similar effect would emerge also in the prioritized remembering group.

A mixed ANOVA on the recall of +10 items, using Volume (quiet vs. loud) and Group (forgetting vs. prioritized remembering) revealed a significant interaction, $F(1,62)=5.10$, $MSE=.023$, $p<.05$ (see Figure 3, right panel). The group effect was not significant, $F(1,62)=2.37$, $p=.13$, and neither was the volume effect, $F(1,62)=1.20$, $p=.28$. To follow up the interaction, I compared the recall of loud and quiet items in each group. There was a recall advantage for loud +10 items over quiet +10 items that emerged only in the forgetting group, $t(31)=2.15$, $p<.05$. There was no such difference in the prioritized remembering group, $t<1$.

For completeness, I also analyzed the recall of +5/-5 items (i.e., less important/detrimental items) using mixed ANOVA, with Volume and Group as factors (see Figure 3, left panel). This analysis is functionally similar to the analyses on TBF items performed in Experiment 1. It allows evaluating the extent to which recall of detrimental words (i.e., -5) in the forgetting group suffered compared to less important words (i.e., +5) in the prioritized remembering group. A Volume (quiet vs. loud) by Group (forgetting vs. prioritized remembering) mixed ANOVA on recall of -5 / +5 items revealed neither a volume effect, nor an interaction effect (both *F*s <1). The overall recall was lower in the forgetting group ($M=.26$, $SD=.12$) than in the prioritized remembering group ($M=.32$, $SD=.14$); however, the main effect of group did not reach conventional significance, $F(1,62)=3.50$, $p=.07$.

JOLs. Table 2 shows JOLs for each group across the point value and volume manipulation. A Volume by Group mixed ANOVA on JOLs showed only a significant main effect of volume, $F(1,62)=65.82$, $MSE=83.26$, $p<.001$. The group effect was not significant, $F<1$, and neither was the interaction, $F(1,62)=2.18$, $p=.15$. Overall, loud items were given higher JOLs ($M=60.26$, $SD=16.71$) than quiet items ($M=47.17$, $SD=16.04$), replicating previous research.

Discussion. To summarize, the critical finding of Experiment 3 was that the recall advantage for loud items emerged only for +10 items, and only in contexts where participants had to engage in intentional forgetting of half of the items. A loud item advantage was not observed in the prioritized remembering group where +10 items were intermixed with +5 items. Overall, the results in the forgetting group replicated previous findings of Experiment 1 in obtaining loud item memory advantage for important items.

The absence of this effect in the prioritized remembering group suggests that engaging in intentional forgetting is critical to producing a loud item recall advantage. However, a closer examination of recall in the prioritized remembering group suggests that participants may not have treated +10 words as more important than +5 words because they remembered +5 and +10 words equally well. If the prioritized remembering group is analyzed by itself using a repeated-measures ANOVA, it does not show a significant effect of value (all Fs<1). Thus, the manipulation of item importance in the prioritized remembering group was less successful than in the forgetting group, where +10 items were recalled better than -5 items. Equivalent recall of +10 and +5 items in the prioritized remembering group is interesting considering that in previous studies, intermixing +5 and +10 values led to recall differences between the two types of items (e.g., Castel et al., 2002; Castel, Farb, & Craik, 2007; Friedman & Castel, 2011). One reason for the absence of the value effect in my experiment may have been due to crossing the positive value manipulation with the volume manipulation (in contrast to previous studies, where positive values were manipulated in isolation). The item's volume feature could have offset the influence of the positive value manipulation (e.g., a loud item followed by +5 points may appear as important as a quiet item assigned +10 points). Interestingly, research by Golding, Roper, and Hauselt (1996) found that people will often adopt a "betting" strategy when presented with an ambiguous cue. For example, when told that an item will have a 100% chance of being tested, participants will be more likely to devote additional processing efforts to that item. When an item has a 50% likelihood of being tested, participants do not devote half as much processing compared to a 100% item, but rather make a decision to process that item all the way, or not at all. It is possible, then, that participants in Experiment 3 tried to devote equal amounts of rehearsal efforts to +5 items as well as +10 items with the intention of maximizing the amount of points they could earn.

CHAPTER V

EXPERIMENT 4

The goal of Experiment 4 was to use a wider range of value points to more successfully manipulate importance in the prioritized remembering group. The experiment was similar to Experiment 3, except that I introduced a new point value manipulation. Specifically, in the prioritized remembering group, items were followed either by +10 points or +0 points; in the forgetting group, I again used +10 and -5 points as before. The selected +10/+0 values not only employ a wider range, but they also create a situation where participants should neither forget the less important items (i.e., the +0 items), nor should they try to remember +0 items to the same extent as +10 words. Participants should try to rehearse +10 items to a greater extent than +0 point items because they have no reason to do any further processing on the +0 items. Note that a +0 cue is not the same as a forget cue because there is no penalty for remembering a +0 item. In contrast, the forgetting group should not only try to remember +10 items more than -5 items, but they should also try to forget the -5 items.

The predictions regarding this experiment are similar to Experiment 3. In addition, I anticipated obtaining a value effect in the prioritized remembering group, which should make the interpretation of results in the forgetting group even stronger.

Method

Participants

Ninety-six participants participated for course credit. None of them had participated in previous experiments.

Materials and Design

The materials, counterbalancing procedures, and the design were identical to Experiment 3.

Procedure

The procedures followed Experiment 3, except that in the prioritized remembering group participants saw +0 value cues and +10 value cues. Finally, all participants completed the post-experimental questionnaire from Experiment 3, which was slightly adjusted to reflect the change in the point values used in Experiment 4.

Results & Discussion

Recall. I first analyzed the recall of +10 items (i.e., important items) using a Volume (quiet vs. loud) by Group (forgetting vs. prioritized remembering) mixed ANOVA because my critical predictions concerned the recall of +10 items. The results are summarized in Figure 4. There was no main effect of volume ($F<1$), but there was a significant main effect of group, $F(1, 94)=5.24$, $MSE=.060$, $p<.05$, and also a significant group by volume interaction, $F(1,94)=4.72$, $MSE=.020$, $p<.05$. The forgetting group remembered loud +10 items better than quiet +10 items ($t(47)=2.05$, $p<.05$), but this difference did not emerge in the prioritized remembering group ($t<1$).

For completeness, I used the same ANOVA to analyze the recall of +0/-5 items (i.e., less important/detrimental items). The main effect of volume was not significant (F<1), and neither was the interaction effect, F<1. There was, however, a significant effect of group ($F(1,94)=5.41$, $MSE=.030$, $p<.05$), with the recall of the +0 items being greater in the prioritized remembering group ($M=.25$, $SD=.14$) than the recall of -5 items in the forgetting group ($M=.19$, $SD=.11$). In other words, the forgetting group attempted to forget the detrimental items (i.e., -5 items) compared to the prioritized remembering group, which had less important items (i.e., +0 items).

Unlike in the previous experiment, the value manipulation led to recall differences in the prioritized remembering group. A repeated-measures ANOVA in the prioritized remembering group, using Value and Volume as factors confirmed a significant effect of value, $F(1, 47)=8.78$, $MSE=.043$, $p<.01$ (Fs<1 for the remaining effects). This result shows that the prioritized remembering group differentiated between the +10 words and +0 words, implying a successful manipulation of item importance.

JOLs. Table 2 shows the JOLs for Experiment 4. One participant's JOL data was lost due to a computer error. A Group by Volume mixed ANOVA on JOLs showed only a significant effect of volume, $F(1, 93)=70.15$, $MSE=147.18$, $p<.001$. Neither the group effect, nor the interaction were significant, Fs<1. Overall, loud items received higher JOLs ($M=61.80$, $SD=18.22$) than quiet items ($M=47.06$, $SD=17.60$).

Discussion. In the current experiment, I obtained recall differences between +0 and +10 value items in the prioritized remembering group, suggesting that participants perceived +10 words as more important than +0 words, and rehearsed those to a greater extent. In light of these findings, I again replicated the previous results in the forgetting group. Loud +10 recall was greater than quiet +10 recall in the forgetting group, suggesting that when participants have to forget some of the items (i.e., -5 items), they remembered loud +10 items over quiet +10 items. Consistent with the previous experiment, volume did not influence recall of "less important/detrimental" items – that is, loud and quiet items that received +0 or -5 point values were remembered the same. Finally, participants rated loud items as more memorable than quiet items in both groups.

Another important finding of Experiment 4 is that when people engaged in intentional forgetting of -5 items, recall for those items was *impaired* compared to recall of +0 items in the prioritized remembering group. This finding has theoretical implications for item-method directed forgetting. If people performed directed forgetting by simply ignoring TBF items, then I would expect recall for -5 items to be comparable to +0 items because people would ignore -5 items the same way they would ignore +0 items. However, I obtained *impaired* recall for -5 items compared to 0 items. It could be that the forgetting group participants were more rigorous in monitoring the source of each item during encoding in order to exclude -5 items from the rehearsal set. In contrast, participants in the prioritized remembering group may have accidentally rehearsed +0 items because there was no cost to remembering these items. Thus, differences in the quality of monitoring across the two groups might account for impaired recall of "detrimental" items. It could also be that intentional forgetting recruits more active inhibitory processes that are different from passive ignoring of TBF items (e.g., Taylor, 2005; Fawcett & Taylor, 2008).

CHAPTER VI

INVESTIGATING THE MECHANISMS PRODUCING THE LOUD ITEM ADVANTAGE

Analyses of Output Dynamics

Thus far, I have interpreted the recall advantage of loud items over quiet items by evoking better encoding of loud items over quiet items in the intentional forgetting groups of Experiment 1, 3, and 4. However, it is possible that the disadvantage of quiet items reflects the influence of certain retrieval dynamics that favors loud items. For example, if loud items were processed more fluently in DF groups, then during free recall these items might be recalled first, causing output interference on the quiet items.

To test the output interference explanation, I evaluated whether the first recalled item was a loud item or a quiet item. A binomial test indicated that the proportion of participants in the DF groups (Experiments 1, 3, and 4) who output a loud item first was 57% (p=.05), while the proportion of participants in the baseline groups who output a loud item first was 56% (p=.07). Overall, there was a tendency for participants to begin recall with a loud item, however the DF groups did not do this more than the baseline groups. The loud item recall advantage observed in the DF groups cannot be attributed to output interference because the degree to which loud items were output first was the same for both groups.

Analysis of Post-Experimental Questionnaire

The intentional forgetting participants recalled more loud TBR items than quiet TBR items, suggesting that they rehearsed loud items to a greater extent than the baseline conditions. Participants in Experiments 1, 3, and 4 were asked "*After studying each word, you made a judgment about it and then there was a blank screen for about 4 seconds. What did you do during the period when the screen was blank?*". If directed forgetting is achieved through a deliberate, strategic rehearsal process whereby participants rehearse previous TBR items that are believed to me more memorable (i.e., loud items) as a way to forget TBF items, I should expected to find a greater percentage of participants reporting rehearsal of earlier items in the DF groups than the remembering groups.

All forgetting groups across Experiments 1, 3, and 4 were combined to form a *global-DF* group (N=128), and the prioritized remembering group from Experiment 3 and Experiment 4 were combined to form a *global baseline* (*BL*) group (N=80). All of these participants had to indicate what they did during the time when the TBF cue (or -5 cue) appeared on the screen. Participants that reported rehearsing previously studied TBR (or +10) items were coded as using a *rehearsal* strategy, whereas those that provided any other type of response were coded as using a *non-rehearsal* strategy. The coding of the responses into the two strategy groups was done by the experimenters and it was unambiguous (i.e., 100% agreement rate). The percentage of participants reporting a rehearsal strategy for Experiments 1, 3, and 4 is presented in Table 3. Below I report the combined analyses across these experiments.

Consistent with the predictions, a chi-square analysis revealed that more participants in the global-DF group (80%) reported rehearsing previous TBR items during TBF trials than did participants in the global-BL group (43%), $X^2(1, N=208)=31.57$, $p<.001$. I also compared the global-DF group against the no-instruction group of Experiment 2. Because the no-instruction group had fewer items to keep in mind than the global BL groups, it had more conducive conditions for selective rehearsal. This group was asked to indicate what they did during the blank interval that was inserted after the JOL trial in lieu of the TBR cue. More participants in the global-DF reported rehearsing previous items compared to the no-instruction group (66%), $X^2(1, N=160)=3.24$, $p=.066$. The results may have fell short of conventional significance because of the small size of the no-instruction group (N=32). Overall, these findings suggest that the intentional forgetting groups engaged in the selective rehearsal of earlier items to a greater extent than did the remembering groups.

In the next step, I examined which type of items participants reported rehearsing more during the experiment in response to the second question of the post-experimental questionnaire. This question asked "*Did you try to remember (a) loud words more than quiet words, (b) quiet more than loud, or (c) did you try to remember the loud and quiet words to about the same extent*?" I evaluated both the frequency of responses across the global-DF and global-BL groups, and also how those responses compared against the actual recall. The global-DF group consisted of the same participants as in the previous analyses, but the global-BL group included more participants, because with an exception of *rehearse-quiet* and *rehearse-loud* groups, all remaining participants were administered a volume-preference question in their questionnaire. This analysis will allow me to measure the magnitude of the loud item recall advantage over quiet items among different groups of DF participants who indicated different types of rehearsal preferences during the experiment.

First, I calculated the difference between the recall of loud TBR/+10 items and the quiet TBR/+10 items because these items showed significant volume effect in my experiments. Then, I plotted the recall difference score by the type of reported volume preference (e.g., rehearsed loud items more, rehearsed quiet items more, or no preference) across the global-DF and global-BL conditions. Figure 5 summarizes the findings. Positive scores on the vertical axis indicate recall advantage for loud items, whereas a score of 0 indicates equivalent recall of loud and quiet items. I statistically evaluated all of the six conditions by comparing the recall difference score to 0 (to determine whether there was a significant loud item advantage), but I report only the significant findings in the text.

More participants in the global-DF group (28%) reported “rehearsing loud items more often” compared to the global-BL group (15%), $X^2(1, N=320)=8.81$, $p<.01$. These reports were confirmed by the actual recall data, which showed that the global-DF participants had a significant recall advantage for loud items ($t(35) = 5.42$, $p<.001$). In addition, fewer participants in the global-DF group (59%) reported “no preference between loud and quiet items” compared to global-BL participants (72%), $X^2(1, N=320)=5.42$, $p<.05$. Interestingly, despite indicating “no preference”, the global-DF participants nevertheless showed significant recall advantage for loud items ($t(75) = 2.74$,

p<.01), suggesting that they were not necessarily aware that they were rehearsing loud items to a greater extent. However, the recall advantage for loud items was much smaller among those indicating “no preference” compared to those reporting “preference for loud items”, $t(110)=2.21$, $p<.05$. Finally, there was no difference in the proportion of responses indicating “rehearsing quiet items more often” across the two global groups, $X^2<1$ (13% in global-DF group and 14% in global-BL group).

The verbal reports analyses suggest that there may be two different mechanisms contributing to the loud item advantage in directed forgetting. The first mechanism is implicated by the group of DF participants reporting rehearsing loud items and, interestingly, these participants showed a robust loud item advantage. Thus, directed forgetting may in part be driven by a controlled strategy to rehearse more memorable items as a way to forget other items. A second group of participants reported having no volume preference but still showed a significant loud item recall advantage. This group may be operating under a different mechanism which produces a loud item recall advantage without conscious awareness. Note that the controlled mechanism produces a twice larger effect compared to the unconscious mechanism, which leads to a much smaller albeit reliable recall effect. Regarding the second mechanism, one possibility is that loud items were processed more fluently and participants may have had an unconscious preference to rehearse more fluently processed items during TBF trials. Another possibility is that loud items captured more attention during encoding because they were highly salient. Highly salient stimuli may provide a desirable context for intentional forgetting because people may associate loud, intense, or highly salient information as good distractions from what they might currently be thinking about. These hypotheses are examined in the next two experiments.

CHAPTER VII

EXPERIMENT 5

Experiments 1 through 4 demonstrated a unique case of preferential remembering for loud items that occurred under conditions of intentional forgetting or when participants were given explicit instructions to rehearse loud items. In contrast, the standard remembering instructions did not produce recall differences across the volume manipulation, whereas JOLs consistently showed loud item advantage. It could be that loud items are processed more fluently than quiet items, and during encoding participants in a directed forgetting task prefer to rehearse fluent items more because ease of encoding is often associated with ease of retrieval (Benjamin & Bjork, 1996; Benjamin, Bjork, & Schwartz, 1998). If loud items have increased retrieval fluency, they might come to mind more easily during TBF trials and be rehearsed to prevent encoding of TBF items. I refer to this hypothesis as the *fluency hypothesis*. Because the ease with which information is encoded and retrieved is thought to be based on metacognitive processes that are mnemonic and nonanalytic (e.g., Koriat, 1997), it is possible that participants who rely on fluency to perform rehearsal in directed forgetting may not be able to report this behavior in a post-experimental questionnaire. In other words, the process may not be accessible to conscious awareness.

If fluency is one of the mechanisms driving the directed forgetting findings observed thus far, then other types of manipulations of fluency should also produce similar effects. In Experiment 5, fluency is manipulated by altering the readability of some items on the list. Items are either presented in an easy-to-read font (i.e., “Arial”) or in a difficult-to-read font (i.e., “Brush”). If fluency is used as a heuristic to perform directed forgetting, I should observe a recall advantage for Arial TBR items compared to Brush TBR items. As before, this advantage should not emerge in an all-remember baseline condition.

Method

Participants

Participants were 64 UNCG undergraduates who participated for course credit. None of them had participated in previous experiments.

Materials and Design

The materials, counterbalancing procedures, and the design were identical to Experiment 1 with the exception that items were presented visually in either 32 pt. Arial font or 32 pt. Brush Script MT.

Procedure

The procedures followed Experiment 1 with the exception that words were presented visually rather than auditorily (i.e., there is no volume manipulation in the current study), the JOL phase was 3 s, and the forget and remember cues were colored rectangles. The forget cue was a red-colored 4” x 2” rectangle centered in the middle of the screen. The remember cue was a green-colored rectangle of the same dimensions and located in the same position.

Results & Discussion

Recall. Figure 6 displays recall proportions for the baseline and DF groups across the font type and cue. Consistent with previous experiments, there was no difference between recall of Arial and Brush items in the baseline group, $t<1$.

A mixed ANOVA on TBR items, using Font Type (Arial vs. Brush) as the within-subjects factor and Group (DF vs. baseline) as the between-subjects factor revealed directed forgetting benefits. Overall, the DF group recalled a larger proportion of TBR items (M=.51, SD=.17) compared to the recall rate in the baseline group (M=.37, SD=.10), $F(1,62)=14.48$, MSE=.041, $p<.001$. The main effect of Font Type and the interaction however were not significant, Fs<1. To assess the costs of directed forgetting, I conducted a similar analysis on recall of TBF items. Replicating previous experiments, the DF group recalled a smaller proportion of TBF items (M=.24, SD=.13) compared to the baseline recall rate (M=.37, SD=.10), $F(1,62)=21.68$, MSE=.027, $p<.001$. The main effect of font type and the interaction were not significant, Fs<1.

JOLs. The JOLs are listed in Table 2. The JOL analysis revealed participants thought Arial items would be rememered better than Brush items, $F(1,62)=14.41$, MSE=31.89, $p<.001$. The effect of Group was not significant, $F<1$, and neither was the Font Type by Group interaction, $F(1,62)=2.00$, p=.16.

The baseline group showed equivalent recall for both Arial and Brush items despite greater JOLs for Arial items than for Brush items. In other words, although participants thought Arial items were more memorable, there was no difference in recall of the two font types in the baseline group. Similarly, the DF group showed no recall differences between the two font types. This finding suggests that Arial items were processed more fluently than Brush items but participants did not disproportionately rehearse Arial items in conditions of directed forgetting.

It is possible that the reason I did not observe a recall advantage for Arial items over Brush items in the DF group is because the overall JOL effect in Experiment 5 was rather small. In contrast, in Experiments 1, 3, and 4, where there was a recall advantage for loud TBR items, the JOL effect favoring loud items was much larger. Thus, perhaps the fluency manipulation using the font type was not as strong as the volume manipulation. One way to address this concern is to look at individual differences in the size of the JOL effect and investigate if there is any recall advantage for Arial items among participants who show the largest JOL difference between the two font types.

The Relationship between the Size of the JOL effect and Recall. I calculated the difference between the average JOLs assigned to Arial items and to Brush items for each participant in Experiment 5, and used this JOL difference measure to divide DF-group participants into three terciles. Participants in the upper tercile showed a 9% JOL effect favoring Arial items, $t(10)=5.95$, $p<.001$; the middle tercile showed a small but significant 2.3% effect in favor of Arial items, $t(10)=5.15$, $p<.001$, and the lower tercile produced a 4.94% JOL effect in favor of Brush items (i.e., the reverse effect), $t(9)=2.99$, $p<.05$. Despite the pattern of JOLs across the three terciles, there was no recall advantage for Arial font items in any of the terciles (the recall results are shown in Table 4, top panel).

In contrast, the same type of analyses performed by combining all of the DF participants from E1, E3, and E4 shows a very different pattern. Specifically, participants in the upper third showed 30% significant JOL advantage favoring loud items, $t(42)=15.96$, $p<.001$; the middle third showed only 9% significant JOL advantage favoring loud items, $t(41)=23.08$, $p<.001$; finally, the lower third showed no difference between JOLs for quiet and loud items, $t<1$. The recall findings favoring loud TBR items were parallel to those of the JOL effect (see Table 4, bottom panel). Namely, the recall advantage for loud TBR items over quiet TBR items was largest in the upper tercile. In the middle tercile, this effect was diminished, although it was still significant. In the lower tercile, there was no longer a significant recall advantage for loud TBR items.

To summarize, DF participants who rated loud items as more memorable than quiet items in Experiments 1, 3, and 4 showed the largest loud item recall advantage, whereas participants who did not rate loud items as more memorable than quiet items did not show this effect. These analyses suggest that the main finding in the DF group across Experiments 1, 3, and 4 (i.e., advantage for loud TBR over quiet TBR items) was greatest among people who held more extreme beliefs about item memorability. In contrast, in Experiment 5, regardless of the size of the beliefs about item memorability, I never observed a recall advantage for Arial font items. Together, these findings do not provide strong evidence that fluency is the mechanism mediating the recall effects in DF groups because it produced different effects in Experiment 5 and Experiments 1, 3, and 4. However, the findings do not provide strong evidence that a fluency mechanism is completely absent as a heuristic for rehearsal in directed forgetting. It is possible that the font type manipulation was not a strong manipulation of fluency. Furthermore, perhaps there are various type of fluency. Changes in the fluency of processing auditory information, like volume, may invoke rehearsal processes in directed forgetting more easily than a visual fluency manipulation like font type. Further investigation is needed to test the fluency hypothesis.

CHAPTER VIII

EXPERIMENT 6

The Experiments 1, 3, and 4 demonstrate that directed forgetting participants have a preference to rehearse loud TBR items during the TBF trials, but they do not necessarily show preference to rehease fluently processed items in Experiment 5, at least when fluency is defined by changing the font type of the studied items. These findings suggest that the preference to rehearse certain types of items in response to directed forgetting is unlikely to be driven by a fluency mechanism. It could be that in response to directed forgetting, participants are simply primed to focus on more salient stimuli during the TBF trials as a way to prevent encoding of TBF items. I refer to this as the *salience* hypothesis of directed forgetting. Everyday observations suggest that when trying to intentionally forget an event like failing an exam or embarassing oneself at work, people tend to play loud music, watch a violent action movie, or go to a loud club or bar. In other words, intentional forgetting may prime the notion of focusing on increased salience as a strategy aimed at preventing reminding of unwanted information.

Stimulus salience has been shown to affect eye saccades and fixations according to top-down and bottom-up processes of visual attention (Fine & Minnery, 2009; Parkhurst, Law, & Niebur, 2002; Peter, Iyer, Itti, & Koch, 2005). Typically, salience is manipulated by varying the color, intensity, size, or orientation of an image presented in a participant's visual field (e.g., Itti, Koch, & Niebur, 1998; Hodsoll, Humphreys, &

Braithwaite, 2006; Fine & Minnery, 2009; von Wartburg, Wurtz, Pflugshaupt, Nyffeler, Luthi, & Muri, 2007). When the size of an image was manipulated, for example, von Wartburg et al. (2009) found that saccade amplitudes increased as the size of the target stimulus increased. In other words, people are quicker to orient their gaze to larger images compared to smaller images.

To investigate the salience hypothesis, I presented participants line drawings of familiar objects. The salience of drawings was manipulated both by changing the size of the drawing itself (i.e., perceptual size manipulation), and by presenting the drawings that represent small or big objects in real world (i.e., conceptual size manipulation). Perceptually large drawings may have increased salience because they take up more space on the computer monitor and thus would be easier to notice. Conceptually large drawings may also have increased salience because they represent objects in the real world that are large in size. Thus if participants are told to imagine that object in their mind, the image would take up more space in the visual field.

In the first phase of the experiment, participants provided JOLs to line drawings that varied in perceptual size and conceptual size. In the second phase, they performed directed forgetting on words. Critically, for half of the participants, I presented a sample of four drawings from the first phase during the TBF trials and instructed participants to select the drawing that, when they looked at it or imaginesd it in their mind, did the best job of helping them forget the TBF item. The remaining participants selected drawings only during the TBR trials. If people intentionally forget or remember by focusing on conceptually or perceptually salient information, they should select conceptually large or perceptually large drawings more often. However, if salience does not matter, then participants should be selecting the four types of drawings at random.

Method

Participants

Participants were 64 UNCG undergraduates who participated for course credit. None of them had participated in previous experiments.

Materials

Materials consisted of 32 words and 64 line drawings. The list of words used in earlier experiments was changed slightly for Experiment 6 in order to minimize the similarity between the words and the line drawings (see Table 1). The line drawings were taken from a database of 520 line drawings of common objects (Snodgrass & Vanderwart, 1980; Szekely et al., 2004) and are displayed in Table 5. Thirty-two of the drawings represented objects that were all smaller than a shoebox (e.g., tweezers, ring, camera), and these items were designated as *conceptually small* drawings. The remaining 32 drawings were designated as *conceptually large* drawings because they represented objects larger than a car (e.g., mountain, house, elephant). A complete list of the items appears in the Appendix. Two versions of each drawing were created in order to manipulate perceptual size. *Perceptually small* items were *.bmp* image files with dimensions of 100 x 100 pixels (approximately 1.04” x 1.04” on a 96 DPI monitor) while *perceptually large* items were images of the same file type with dimension of 300 x 300 pixels (approximately 3.125” x 3.125” on a 96 DPI monitor)[1].

The likelihood that a given drawing would appear perceptually large versus perceptually small was counterbalanced across participants. Furthermore, an attempt was made to equate the conceptually large drawings and conceptually small drawings on familiarity and complexity. A group of 40 participants rated all 64 drawings on how familiar the object represented by each picture was, and how complex each drawing was using a scale from 1 to 5, where higher numbers represent greater familiarity and complexity. While drawings did not differ on familiarity ratings (M=3.11, SD=.67 for conceptually small drawings, and M=2.93, SD=.87 for conceptually large drawings) (ts<1), conceptually large drawings received higher complexity ratings (M=3.46, SD=.71) compared to conceptually small drawings (M=3.01, SD=.58), $t(31)=2.69$, $p<.05$. Thus, whereas conceptually large and conceptually small drawings were considered to be equally familiar, the drawings of larger objects were rated as inherently more complex. I address this limitation in the General Discussion section.

Procedure

There were two major phases in this experiment, consisting of (1) rating the drawings, and (2) completing the directed forgetting task involving words. Initially, participants were presented with line drawings for 5 s each and had 4 s to provide a JOL for that drawing using the same instructions as in the previous experiments. Presentation order of the drawing types was randomized with the constraint that no more than four *size attributes* of the same type were presented in a row. For example, no more than four perceptually large drawings, regardless of the conceptual size, were presented in a row.

Following the ratings of drawings, participants completed an item-method directed forgetting phase on words combined with a picture selection task on a subset of trials. Participants studied 32 nouns for 3 s each. After each word was presented, a green or red rectangle appeared for 1 s serving as a TBR or TBF cue for that word respectively. The likelihood that a given word was followed by a TBR or TBF cue was counterbalanced across participants, and the presentation order of words was randomized with the constraint that no more than three TBR or three TBF items appeared in a row.

Following the presentation of the TBR or TBF cues, a sample of four drawings from the first phase of the experiment were presented in a two-by-two matrix. The four drawings represented one drawing from each of the four size categories (e.g., conceptually small / perceptually small, conceptually small / perceptually large, conceptually large / perceptually small, or conceptually large / perceptually large). For half of the participants, the four images were shown only after the TBF cues (select-to-forget group), whereas for the remaining participants the images were shown only after the TBR cues (select-to-remember group). Participants in the *select-to-forget group* were told that after each TBF trial they would see a sample of four images from earlier and that they should select the drawing that, when they looked at it or imagined it in their mind, helped them *forget* the most recently presented word. Selection was made by a simple mouse click on the image. Participants in the select-to-remember group were instructed to select the drawing that when they looked at it or imagined it in their mind, helped them *remember* the most recently presented TBR item. The selection of the four images from the earlier phase was randomized without replacement, and the position that a given image occupied on the screen within the array was randomized on each trial. After the encoding of the words and the picture selection procedure, participants completed the same distractor task as in the previous experiments for 1 min, and finally were told to recall all the words they had studied, including the TBF words. Four minutes were allocated for the recall task as in the previous experiments.

Design

In the first phase, participants saw drawings that varied in perceptual size (small vs. large) and conceptual size (small vs. large), with both variables being manipulated within subjects. In the second phase, the design involved a group (select-to-forget vs. select-to-remember) by cue (TBF vs. TBR) mixed factorial, with group as the between-subjects variable, and cue as the within-subjects variable.

Results & Discussion

JOLs. First I present results of the analysis on JOL data collected during the first phase of the experiment (see Table 2). A Conceptual Size (small vs. large) by Perceptual Size (small vs. large) repeated measures ANOVA was conducted on average JOLs. There was a significant effect of Perceptual Size, $F(1,63)=81.42$, $MSE=152.53$, $p<.001$, with perceptually large drawings receiving higher JOLs ($M=58.61$, $SD=15.40$) than small drawings ($M=44.68$, $SD=15.61$). Neither the effect of conceptual size nor the interaction were significant, Fs<1. Thus, participants did not rate images representing large objects in the real world as any more memorable than images representing smaller objects. However, they thought that images occupying larger space on the computer monitor were more memorable than images occupying smaller space on the monitor, regardless of the size of the actual object represented by the image. The findings of perceptual size manipulation are reminiscent of prior research, which documents higher JOLs being given to words presented in large font than small font (Rhodes & Castel, 2008). The findings with drawings in the current experiment suggest that size manipulations in general may evoke beliefs of higher memorability regardless of the nature of stimuli.

***Recall in the Directed Forgetting Task*.** The next set of analyses address recall performance in the second phase of the experiment. Specifically, I evaluate how recall of TBR and TBF words differed when people selected drawings as a way to remember or forget the word. Figure 7 shows the recall rates for both selection groups as a function of cue. A Group (select-to-forget vs. select-to-remember) by Cue (TBF vs. TBR) mixed ANOVA revealed a significant effect of Cue, $F(1,62)=122.67$, $MSE=.019$, $p<.001$, with better recall of TBR items ($M=.41$, $SD=.18$) compared to TBF items ($M=.13$, $SD=.10$), implicating a directed forgetting effect. The main effect of Group was not significant, $F(1,62)=2.28$, $MSE=.020$, $p=.14$. However, there was a significant interaction, $F(1,62)=6.26$, $MSE=.019$, $p<.05$. While recall of TBF items did not differ across the select-to-forget and select-to-remember groups ($t<1$), recall was higher for TBR items in the select-to-remember group than in the select-to-forget group, $t(62)=2.34$, $p<.05$. These findings mean that memory for TBR items improved when participants selected a drawing in order to remember TBR words compared to when they tried to remember the TBR words with no drawings (this is, because the select-to-forget group did not have drawings during the TBR trials).

Selection of Drawing Types. The next set of analyses was conducted to see if participants had a systematic preference to select images of a certain size as a way to remember or forget words. For example, if people prefer perceptually salient stimuli when trying to forget information, participants should select perceptually large images in the select-to-forget group. On the other hand, in the select-to-remember group, participants may not be sensitive to either perceptual or conceptual salience because they will just try to relate the word to the object in the drawing regardless of its size.

Figure 8 shows the percentage of trials that each image type was selected in the two groups. For example, out of the 512 trials in the select-to-remember group (i.e., 16 TBR trials for each of 32 participants) conceptually large/perceptually small images were chosen on 25% of the trials. I modeled the preferences (yes/no) for the four different types of drawings across trials using generalized estimation equations with a logit link. The predictors of the preferences were Group (select-to-forget group/select-to-remember), Perceptual Size (large/small), and Conceptual Size (large/small), and the interactions between these variables. The Perceptual Size factor was significant, Wald $X^2(1, N=64)=11.00$, $p<.01$, suggesting that participants from both groups preferred to select perceptually large drawings more than perceptually small drawings. The Conceptual Size factor was not significant, Wald X^2 (1, N=64)=.47, $p=.50$, but there was a significant Group by Conceptual Size interaction, Wald X^2 (1, N=64)=4.20, $p<.05$. The Group by Perceptual Size interaction was not significant, Wald X^2 (1, N=64)=1.25, $p=.26$, and neither was the Perceptual Size by Conceptual Size interaction, Wald X^2 (1, N=64)=.27, $p=.60$.

To follow up the Group by Conceptual Size interaction, I constructed an equation that tested the influence of Perceptual Size and Conceptual Size on the selection of drawings in the select-to-remember group only. The Conceptual Size factor was significant, Wald X^2 (1, N=32)=11.58, p<.01, as was the Perceptual Size factor, Wald X^2 (1, N=32)=10.55, p<.01. The interaction, however, was not significant, Wald X^2 (1, N=32)=.52, p=.47. The same analysis performed on the select-to-forget group revealed a significant effect of Perceptual Size, Wald X^2 (1, N=32)=8.63, p<.01. The Conceptual Size was not significant, Wald X^2 (1, N=32)=.09, p=.76, and neither was the interaction, Wald X^2 (1, N=32)=.001, p=.98.

Overall, when selecting drawings to help with remembering TBR words, participants showed a preference for both conceptually large and perceptually large drawings. In contrast, when selecting drawings to help them forget TBF words, participants only preferred perceptually large drawings.

Does Selecting Certain Types of Drawings Affect Recall of Words? The results of the drawing selection analysis suggest that participants select different types of images when they are aiming to forget than when they are aiming to remember words. Furthermore, in the prior analyses of recall in the directed forgetting task, I have shown that memory for TBR items improved when participants selected a drawing in order to remember those words compared to when they tried to remember the TBR words with no drawings. Given that selection of drawings happened only during half of the trials of directed forgetting task (e.g., either on TBF trials or TBR trials), I analyzed the recall of individual items from the trials where the drawing selection task was performed. The goal was to evaluate whether selecting certain types of drawings affected later recall of the word that was just studied, which would mean that certain drawing are more effective for forgetting or remembering. Perhaps conceptually larger drawings helped encode TBR items in the select-to-remember group because people were quicker to make associations between the TBR word and the large objects. Since conceptually large objects were given higher complexity ratings, it could be that they more easily lend themselves for creating spontaneous associations with the TBR words than if an object is rather simple. Likewise, in the select-to-forget group, selecting perceptually large / conceptually small drawings immediately following TBF cues may be more likely to prevent participants from encoding the TBF item because attention is more quickly averted to the perceptually large drawings and small conceptual size may help because small / simple objects may prevent the formation of spontaneous associations with the TBF word (unlike a conceptual large drawing that may lead to inadvertent associations with TBF word, preventing its forgetting). The quicker participants can focus their attention on something unrelated to the TBF item, the less likely they should be able to recall that TBF item later on.

To assess how selecting a given drawing type affected subsequent memory of individual words in the directed forgetting task, I modeled recall (0=not recalled/1=recalled) for the four different types of drawings across trials using generalized estimation equations with a logit link. The predictors of the preferences were Group (select-to-forget group/select-to-remember), Perceptual Size (large/small), and

Conceptual Size (large/small), and the interactions between these variables. The model parameters are listed in Table 6.

The group factor significantly predicted recall (implying a directed forgetting effect), but neither of the size factors nor the interaction terms significantly predicted recall. Therefore, selecting a specific type of drawing did not contribute to increased remembering of TBR items in the select-to-remember group, nor did it contribute to increased forgetting of TBF items in the select-to-forget group.

These results suggest that the tendency to select certain types of drawings as a way to forget versus remember words did not actually affect recall for those words. Although the select-to-remember group preferred conceptually large and perceptually large drawings, selecting these drawings did not actually increase the likelihood that the preceding word would be better remembered. Similarly the select-to-forget participants had a tendency to select perceptually large drawings, suggesting that they thought these types of items would be more effective for forgetting. This was not the case, however, because the size of drawing selected had no influence on the likelihood that the preceding word would be forgotten. These results suggest that participants may have beliefs about which items help them remember or forget, but acting on those beliefs does not translate into recall differences.

Post-hoc Analyses of Semantic Content of Selected Drawings. Although the images in Experiment 6 varied in conceptual size (and perceptual size), they also varied in semantic content. Thus, it is possible that a preference for selecting conceptually large images in the select-to-remember group was driven by the content of those images. In a post-hoc analyses, I was able to categorize the images into four semantic themes: Everyday Items (e.g., *match, shoe, glasses*), Locations (e.g., *house, bridge, church*), Living Things (e.g., *grasshopper, elephant, dragon*), and Vehicles (*boat, tractor, rocket*). If participants select drawings in order to evoke particular forms of semantic associations, they may select different themes to help them remember words compared to when they want to forget words. I calculated the percentage of times a given theme was selected in the select-to-remember and select-to-forget groups. The results are displayed in Table 7. The only significant difference across the two groups was for the Locations theme, with participants selecting location drawings more often as a way to remember words than when trying to forget words, $t(62)=2.01$, $p<.05$. Although there were numerical differences between selection groups for the remaining themes, the comparisons did not reach statistical significance, *p*s>.10.

Perhaps select-to-remember participants select conceptually large drawings because they are actually showing a preference for the drawings that are Locations. It could be that there is something special about Locations that helps with remembering TBR words. For example, it may be easier to create associations with the target word and a location (e.g., “object A is in location B”). If Locations are conceptually large drawings, this could explain the tendency to select conceptual large drawings. I calculated a Pearson’s *r* correlation coefficient between Conceptual Size and Locations, and indeed, there were positively correlated, $r(62)=.55$, $p<.001$. To test if participants selected drawings because of Conceptual Size or Location, I compared the proportion of drawings selected that were of locations versus non-locations only for the conceptually large drawings. If the reason the select-to-remember group preferred conceptually large drawings is because these drawings were often of locations, and their decision was driven more by the semantic content of these location drawings, then I should expect a greater proportion of conceptually large location drawings to be selected compared to conceptually large non-locations. This was not the case, however. The average number of times a conceptually large location drawing was selected was the same (M=4.44, SD=1.81) as that of a conceptually large non-location (M=4.50, SD=2.05), Wald X^2(1, N=32)=1.20, p=.27. These results indicate that the tendency for the select-to-remember group to select conceptually large drawings more often than conceptually small drawings was guided by conceptual size information rather than semantic information.

Discussion. When instructed to select drawings as a way to remember TBR words, participants showed a preference to select drawings that represented larger objects as well as drawings that were perceptually larger. In contrast, when participants were instructed to focus on images that helped them forget TBF words, they only selected perceptually large images. In other words, the preference for conceptually large images observed in the select-to-remember group disappeared when participants were instructed to select images that would help them forget words.

Perhaps when trying to forget, participants are drawn towards perceptually large drawings because these drawings are most effective in grabbing their attention and distracting them from the TBF word. Furthermore, these participants choose to ignore the conceptual features of the drawings because conceptually large drawings may spontaneously give rise to associations. In contrast, when trying to remember TBR words, participants may be oriented towards perceptually large drawings but they also may focus on the conceptual features of the drawings because they think conceptually large drawings will be easier to associate with the TBR word.

The image selection results of Experiment 6 contrast with the recall results. Although directed forgetting was observed for both selection groups, the results of the logistic regression analysis suggest that the type of picture selected on a given trial had no influence on recall of the preceding word during the final test. In other words, the tendency for the select-to-forget group to select perceptual large images did not contribute to more forgetting of TBF items because recall for a word was not affected by the perceptual size of the selected drawing on that trial. Similarly, although the select-to-remember group tended to show a preference for conceptual largeness and perceptual largeness, selecting these types of pictures did not actually contribute to increased recall of TBR items compared to trials in which conceptually small or perceptually small drawings were selected.

Finally, I evaluated whether the semantic content of the drawings was related to which drawings participants selected. There appeared to be a tendency to select drawings that were of locations in the select-to-remember group, but it was primarily driven by the conceptual size factor.

CHAPTER IX

GENERAL DISCUSSION

Across the first four experiments I demonstrated a unique case of preferential remembering that occurred only under conditions of intentional forgetting or when participants were given explicit instructions to rehearse loud items. In Experiment 1, recall for loud and quiet items was the same under the standard remembering instructions (i.e., in the baseline group), but not in the DF group. When participants engaged in directed forgetting, the effect of volume on recall differed depending on whether the item was TBF or TBR. Although volume had no effect on TBF recall, loud TBR items were remembered better then quiet TBR items implicating that DF participants rehearsed loud items to a greater extent than quiet items. These findings suggest that there was an influence of metamemory on directed forgetting because rehearsal was dominated by the items that participants believed to be more memorable. Experiment 2 demonstrated that when opportunities were created for additional rehearsal by eliminating TBF trials and replacing them with an unrelated task, participants did not show a preference for rehearsing loud items, suggesting that having a goal to forget information is critical for observing a loud item recall advantage.

Experiments 3 and 4 provided additional evidence that engaging in intentional forgetting was necessary for obtaining a selective advantage of loud items. The loud item recall advantage was observed when positive value items were intermixed with negative value items, but not when graded positive values were used. Specifically, loud +10 items were better recalled than quiet +10 items, but only when those +10 items were intermixed with -5 items in the list. I did not observe the same effect when +10 items were intermixed with +5 items (Experiment 3) or with +0 items (Experiment 4). These results suggest that experimental manipulations merely emphasizing some items over others in the context of remembering (without involving intentional forgetting) do not produce loud item advantage. Engaging in intentional forgetting of some items is critical for observing selective advantage of loud items. The analyses of output dynamics in Experiments 1, 3, and 4 suggest that loud items were just as likely to be recalled early in the recall sequence as quiet items across both DF conditions and baseline conditions. Therefore, the quiet item disadvantage in directed forgetting groups cannot be a result of output interference.

The verbal reports analyses further confirmed that during the experiment, DF participants tended to rehearse previous TBR items more frequently than the BL participants. Importantly, more DF participants reported a preference for rehearsing loud items than BL participants, and it is the DF participants who actually showed a significant loud item advantage, whereas the BL participants did not. Finally, the majority of participants reported having no particular preference for either type of item during rehearsal, but the rates of such strategy were lower in the DF group than in the BL group. Interestingly, despite reporting no preference for either type of item, the DF participants nevertheless showed a significant loud item advantage whereas the BL participants did not.

Overall, the results of these experiments along with the verbal reports analysis suggest that there may be two different mechanisms contributing the observed effects of volume on directed forgetting. The first mechanism indicates engagement of a controlled strategy aimed at forgetting. Many DF participants reported rehearsing loud items during the experiment, and they indeed showed the greatest loud item advantage. This implies that some participants were rehearsing the items they deemed as highly memorable in response to the forget cue out of desire to disengage from the current TBF item. The second mechanism underlying the loud item advantage in the DF group could involve some type of unconscious priming favoring loud items because 59% of the DF participants reported rehearsing both types of items equally well, yet the recall findings from those participants indicated that they remembered loud items better than quiet items. This suggests that some DF participants were not aware that they rehearsed loud items to a greater extent than quiet items, and the TBF cues may have unconsciously primed participants to prefer loud items. Although research has shown that people use encoding fluency as a mnemonic cue to make JOLs (Benjamin & Bjork, 1996; Benjamin, Bjork, & Schwartz, 1998; Koriat & Ma'ayan, 2005), the results of Experiment 5 suggest that a fluency mechanism is not likely to be operating in directed forgetting. In other words, participants were not rehearsing fluent (i.e., Arial font) TBR items more than disfluent (i.e., Brush font) TBR items when trying to perform directed forgetting in Experiment 5 .

Further evidence against the fluency mechanism comes from the individual differences analyses, relating the size of the JOL effect for loud and quiet items to the recall of those items in directed forgetting. In Experiments 1, 3, and 4, the greater the

JOL difference between the loud and quiet items, the greater the likelihood that participants would recall more loud TBR items compared to quiet TBR items, implicating a link between metamemory and directed forgetting. In contrast, a similar relationship between the size of the JOL effect and recall was absent in Experiment 5. That is, people who thought Arial items were more memorable than Brush items did not remember more Arial TBR items when engaged in directed forgetting.

An alternative to the fluency hypothesis is the *salience* hypothesis. In Experiment 6, I tested the idea that directed forgetting instructions prime people to prefer salient stimuli because they may associate highly salient stimuli with successful instances of intentional forgetting. For example, when people try to get something out of their mind, they may automatically seek environments full of intense energy, loud music, and bright lights because such a highly salient atmosphere allows for good distraction as it makes it hard to ruminate on the "problem" that one is trying to put out of mind. The results of Experiment 6 suggest that the types of stimuli people prefer to think about differ depending on whether people use the stimuli to help them remember or forget information. When selecting drawings to help forget words, people tended to focus on perceptual size information while ignoring conceptual size altogether. In contrast, when drawings were used to help remember words, people used perceptual size and conceptual size information to select a drawing.

I propose that when participants select drawings to help remember words, they evaluate the conceptual features of the drawings and tend to select drawings that are conceptually large. Conceptually large drawings are in general more complex and participants may believe that complex drawings lend themselves to more elaborate associations to the TBR word. In contrast, when participants select drawings to help forget words they may ignore drawings' conceptual features. These participants select both conceptually small and conceptually large drawings equally often. Although many of the conceptual large drawings were of specific locations, suggesting that people may have a preference for selecting location drawings when trying to remember words, there was no difference in the proportion of drawings selected that were of locations compared to non-locations among conceptually large drawings. Thus, the preference people had for conceptually large drawings was attributable to the drawings' conceptual size, and was not driven by a specific preference for location drawings. Perceptually large drawings, on the other hand, may capture attention for all participants and this is why I observed a tendency for participants in both groups to select perceptually large drawings.

The tendency to select certain types of drawings did not influence recall. Specifically, selecting conceptually or perceptually large drawings did not improve recall of the preceding word, and selecting perceptually large drawings did not lead to increased forgetting of the preceding word. I interpret these results as an example of illusory beliefs similar to what was observed with the volume manipulation used in Experiments 1, 3, and 4. When participants studied loud and quiet items, they gave higher JOLs to loud items, yet recall in the standard baseline conditions showed no difference between the loud and quiet words, suggesting an illusory belief. In the DF conditions, however, this illusory belief was used to engage in selective rehearsal of the items people thought were more memorable (i.e., loud items). Interestingly, such strategy only led to an increased recall of loud TBR items compared to quiet TBR items, but it did not lead to more effective forgetting of TBF items. In Experiment 6, I gave participants a choice of what to think about (i.e., the drawings) when attempting to remember or to forget words. The select-to-forget group preferred perceptually large drawings, although this selection had no effect on recall suggesting that selection preference was driven by an illusory belief. An influence of illusory belief emerges also in the select-to-remember group because they selected perceptually large and conceptually large drawings, but this selection behavior did not increase remembering.

An intriguing result from Experiment 6 is the finding that the overall recall of TBR items was greater in the select-to-remember group compared to recall of TBR items in the select-to-forget group. In other words, selecting some type of drawings after the TBR trials (as opposed to no drawings) helped with recall of TBR items later on. I interpret this finding in terms of more elaborative processing of TBR words presumably because participants were trying to associate them with the drawings (although the specific type of drawing apparently did not matter in enhancing recall).

Rehearsal as an Active Mechanism in Directed Forgetting

Results of the current study have implications for theories of item-method directed forgetting. Prior research using the item method suggests that forgetting is guided by a rehearsal process where an item is first processed and rehearsed upon presentation. Rehearsal then continues for items that receive a TBR cue, but stops for items that receive a TBF cue. Intentional forgetting was mostly believed to arise from a passive process of not rehearsing TBF information (e.g., Bjork, 1972; MacLeod, 1999).

In contrast, Taylor (2005) and colleagues (Fawcett & Taylor 2008; 2010; Hourihan & Taylor, 2006) have argued that forgetting arises from an active process that operates by inhibiting rehearsal of the TBF item. Wylie, Fox, and Taylor (2007) have identified brain regions that are active during trials associated with successful intentional forgetting later on, and they have shown that these areas are distinct from the areas associated with accidental/unintentional forgetting. I agree with the notion that forgetting of TBF items requires an active process that is different from merely ignoring TBF items during encoding. As suggested earlier, results from the current set of experiments along with the verbal reports analysis indicate that participants rely on two distinct processes of intentional forgetting, a deliberate rehearsal strategy and a salience mechanism. Both processes are active in the sense that forgetting is achieved through engagement of rehearsal. The processes differ regarding whether or not the content of rehearsal is accessible to conscious awareness. However, both processes have metacognitive monitoring and control mechanisms that influence the nature of rehearsal.

When people use a conscious selective rehearsal processes to forget information in item-method directed forgetting, they rely on metacognitive beliefs about how memorable previously encountered information is in order to select which items to rehearse. The greater the perceived memorability of information, the greater the likelihood that the information will be rehearsed following a forget cue. Thus, I propose that, when engaged in item-method directed forgetting, participants select to rehearse items that they believe are memorable as a deliberate strategy to help them forgetting. Conceptually, this mechanism shares similarities with the mechanisms used to explain the list method of directed forgetting (Sahakyan & Kelley, 2002). In list method studies, participants often retrieve extra-experimental distracting thoughts in response to the forget cue as a strategy to help them forget the unwanted items (Foster & Sahakyan, 2011; Sahakyan & Kelley, 2002). The forget cue in the list method is presented only once after an entire list has been presented, and participants must forget all the items they have studied until that point. Thus, the list-method participants are more likely to retrieve other, unrelated thoughts from episodes prior to the experiment in order to forget unwanted items. In contrast, in the item-method studies, participants could retrieve the TBR items presented earlier as a way to prevent encoding of TBF items. In general, prior information can be strategically used to disengage from the TBF items in order to forget unwanted information.

When selective rehearsal is driven by a salience mechanism in order to engage in item-method directed forgetting, participants rehearse previous information that they believe is more memorable, but they do so in the absence of any explicit awareness or deliberate strategy. Instead, the rehearsal preference is guided by an implicit notion that bringing highly salient information to mind can disrupt encoding processes and increase the likelihood that recently learned information will be forgotten. This process may have been engaged by the participants in Experiments 1, 3, and 4 who did not report having rehearsal preference but still remembered more loud TBR items than quiet TBR items. Furthermore, the results of Experiment 6 suggest that perceptual salience is preferred and conceptual salience is ignored when the goal is to forget words. When the goal is to use drawings to help remember word, both perceptual and conceptual salience becomes important. Thus, people carry an illusory belief that increased perceptual salience helps with intentional forgetting, and increased conceptual salience as well as perceptual salience helps with remembering.

The Importance of Metacognitive Monitoring: Evidence from Judgments of Learning

The metacognitive framework proposed by Nelson and Narens (1990) indicates that information gathered by monitoring processes informs control processes and helps regulate learning. The same type of process may be operating in directed forgetting. Here, monitoring of the memorability of items during learning can be used to inform rehearsal processes when an instruction to forget is given. Thus, the role of metacognition in directed forgetting depends on participants thinking that some types of items are more memorable than others.

Judgments of Learning effects were observed across all six experiments. In particular, participants in Experiments 1, 2, 3, and 4 thought loud items would be more memorable than quiet items, except in the rehearse-quiet condition in Experiment 2, where JOLs for quiet and loud items were not different. In Experiment 5, Arial items were judged as more memorable than Brush items. Participants in Experiment 6 judged perceptually large drawings, regardless of conceptual size, as more memorable than perceptually small drawings. The results of the JOL analyses across the six experiments suggest that beliefs about the memorability of certain types of items over others could play a critical role in directed forgetting. Results of Experiment 5, however, indicate that thinking some types of items are more memorable than others is not sufficient to produce the effect because DF participants did not selectively rehearse Arial TBR items as a way to forget TBF items. In addition to carrying beliefs about the memorability of items, the beliefs must be guided by perceptual salience, rather than encoding fluency, in order for people to engage in selective rehearsal of those types of items in response to the demands of intentional forgetting.

Implications for Research on Metacognitive Control

The agenda-based model of metacognitive control has been invoked to explain self regulation of remembering. Results from the current experiments can be used to extend this model to help explain the self regulation for *forgetting*. The efficiency of goal attainment has been emphasized as an important component of the self regulation of learning (see Ariel, Dunlosky, & Bailey, 2009; Thiede & Dunlosky, 1999), and it may also be an important component in processes of self-regulated forgetting. Overall, the role of an agenda in selective rehearsal could be to help determine what types of items should be rehearsed in order to meet the demands of the current task. When the goal is to remember, rehearsal may be allocated to items that participants think will help them remember the most number of items, and the types of items rehearsed is often dictated by current task demands (e.g., Dunlosky & Hertzog, 1998; Metcalfe & Kornell, 2005). When a goal to forget is introduced, however, rehearsal efforts might shift to focus on items that are perceived to be more memorable or towards perceptually salient information. Overall, these studies provide the first evidence for the role of metacognitive control in directed forgetting.

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APPENDIX A

TABLES

Table 1

Study Items from Experiments 1, 2, 3, 4, 5, (left) and 6 (right).

air	ambassador
ambassador	artist
angle	barrel
barrel	butter
book	candle
boss	chapter
car	circle
charter	competition
claw	concert
competition	cowboy
convention	creature
creature	engine
devil	fabric
fabric	gallery
gallery	garage
garments	girlfriend
gift	hospital
harness	jaguar
hospital	leather
intimate	library
joke	metal
lad	method
lark	morning
lawn	newspaper
metal	orchid
method	ornament
newspaper	penguin
odor	prisoner
party	salad
queen	seat
salad	shadow
unit	turnip

Table 2

Mean Judgments of learning (JOL) by experiment, condition, and volume/font-type. Values in brackets represent ± SE of the mean.

Experiment 1	***DF group***	***Baseline group***
QUIET	55.35 (2.55)	49.10 (2.69)
LOUD	65.10 (2.10)	60.93 (2.59)

Experiment 2	***Extra-Rehearsal***	***Rehearse Loud***	***Rehearse Quiet***	***No-Instruction***
QUIET	52.84 (3.32)	48.79 (3.26)	57.57 (3.73)	56.24 (3.28)
LOUD	60.40 (3.47)	68.37 (2.81)	58.84 (3.78)	62.64 (3.27)

Experiment 3	***Forgetting group***		***Prioritized Remembering***	
	-5 items	**+10 items**	**+5 items**	**+10 items**
QUIET	47.10 (3.06)	47.48 (3.49)	47.08 (2.70)	47.03 (2.60)
LOUD	64.22 (3.57)	61.26 (3.29)	56.10 (3.14)	59.43 (2.91)

Experiment 4	***Forgetting group***		***Prioritized Remembering***	
	-5 items	**+10 items**	**+0 items**	**+10 items**
QUIET	44.62 (2.76)	48.64 (2.67)	45.63 (2.47)	49.36 (2.83)
LOUD	59.40 (2.82)	61.90 (2.76)	62.49 (2.67)	63.44 (2.70)

Experiment 5	***DF group***	***Baseline group***
BRUSH	54.97 (3.24)	54.13 (3.25)
ARIAL	57.35 (3.25)	59.33 (3.28)

Experiment 6

Conceptual Size	small	large

Perceptual Size		
small	44.52 (2.24)	44.83 (1.85)
large	58.18 (2.14)	59.03 (1.88)

Table 3

Percentage of Participants who Reported Rehearsing Previous TBR Items During TBF Trials (Experiment 1), or Rehearsing +10 Items During -5/+5 Trials (Experiment 3), or -5/+0 Trials (Experiment 4).

Condition	***Experiment 1***	***Experiment 3***	***Experiment 4***
Directed Forgetting Groups	94%	69%	75%
Prioritized Remembering Groups	--	22%	56%

Table 4

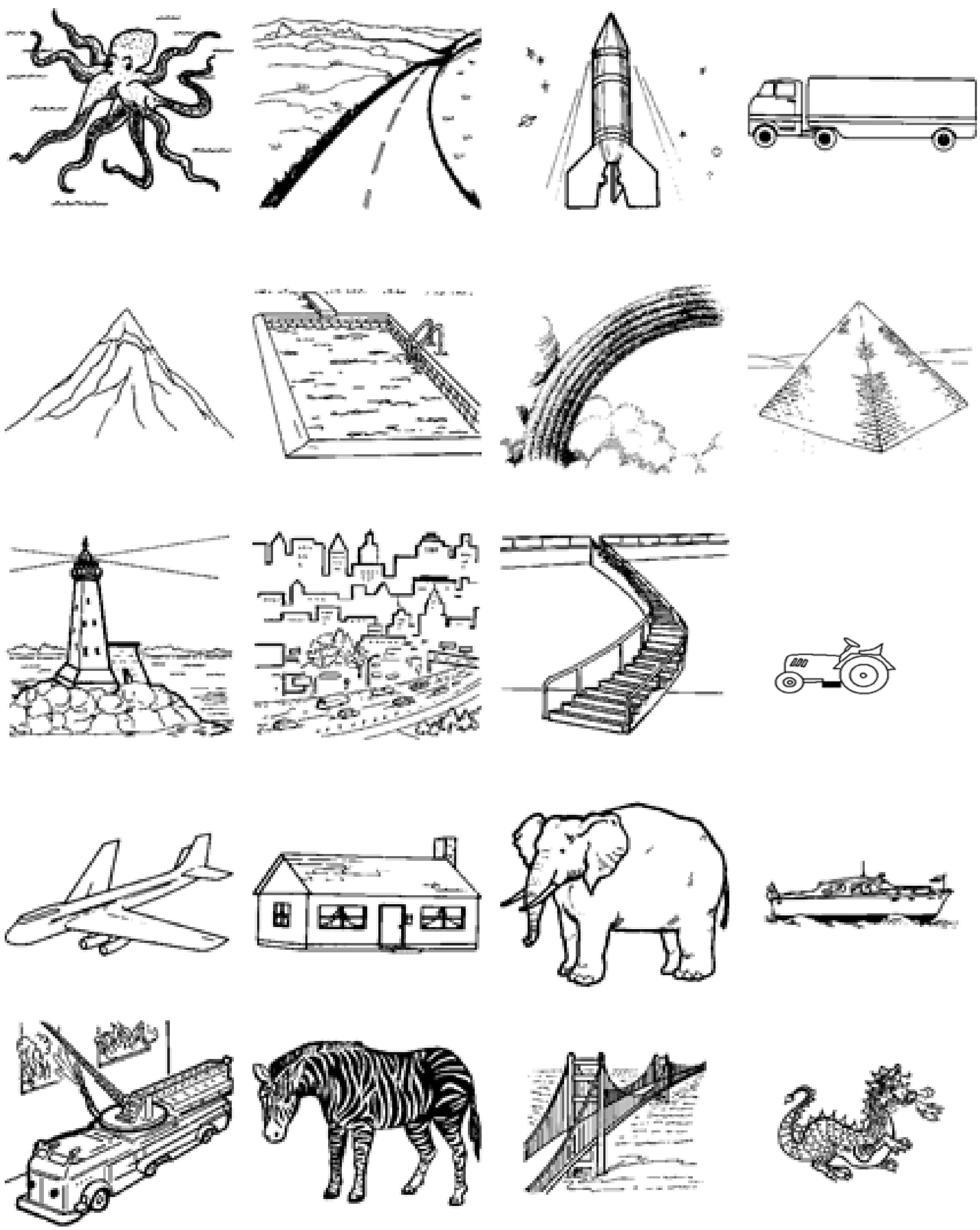
Recall for Arial and Brush TBR items in Experiment 5 (top panel), and for Loud and Quiet TBR items collapsed across Experiments 1, 3, and 4 (bottom panel), as a function of JOL terciles. Values in brackets represent ± SE of the mean.

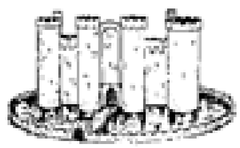
JOL Tercile	***Brush TBR***	***Arial TBR***	***t***	***df***	***p-value***
lower	.52 (.07)	.45 (.07)	1.07	9	.31
middle	.47 (.05)	.50 (.07)	.48	10	.64
upper	.52 (.05)	.57 (.06)	1.10	10	.30

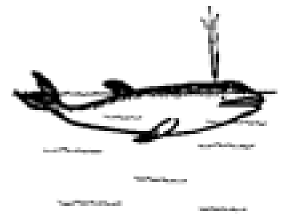
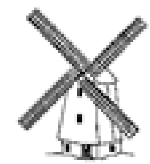
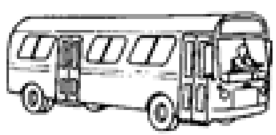
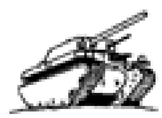
JOL Tercile	***Quiet TBR***	***Loud TBR***	***t***	***df***	***p-value***
lower	.47 (.03)	.51 (.03)	1.71	42	.25
middle	.38 (.03)	.45 (.03)	2.64	41	.01
upper	.32 (.03)	.45 (.03)	3.70	42	.001

Table 5

Drawings used in Experiment 6.

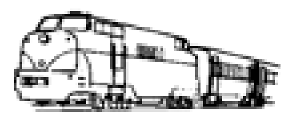


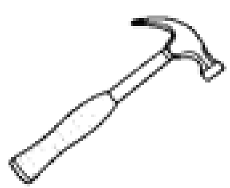


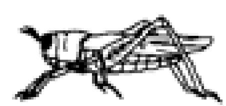
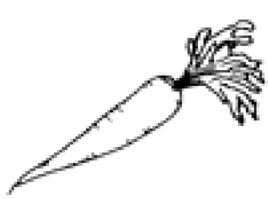
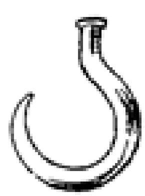





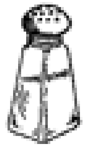


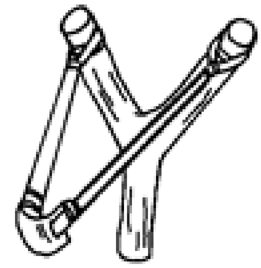
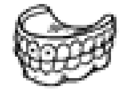


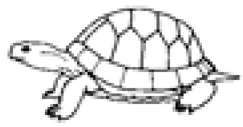
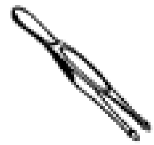
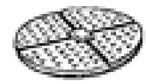
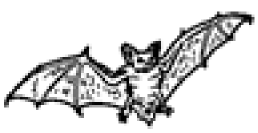
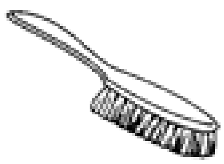
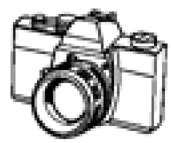


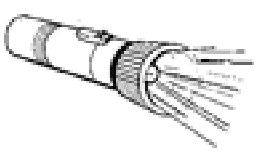


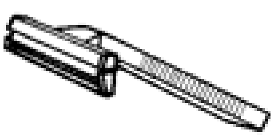


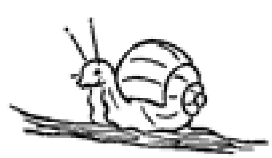
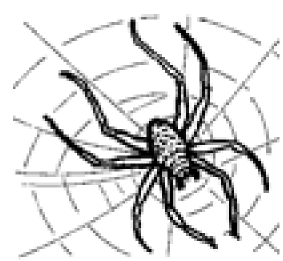









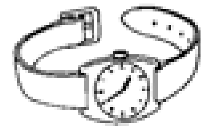
   

Table 6

The Effect of Group, Conceptual Size, and Perceptual Size on Recall in Experiment 6.

	Model Parameter Estimates				
Factors	***B***	***S.E.***	***Wald χ^2***	***df***	***p-value***
Group	1.27	.39	10.60	1	<.01
Conceptual size	-.48	.39	1.48	1	.22
Perceptual size	-.25	.38	.43	1	.51
Group x Conceptual size	.81	.49	2.72	1	.10
Group x Perceptual size	.35	.46	.58	1	.45
Perceptual size x Conceptual size	.70	.58	1.43	1	.23
3-Way Interaction term	-1.05	.71	2.23	1	.14

Table 7

Percentage of Drawing Selection by Theme and Group in Experiment 6.

Drawing Themes	**Select-To-Remember**	**Select-To-Forget**	***t***	***df***	***p-value***
Everyday Items	27.49%	31.28%	.97	62	.34
Locations	21.65%	17.00%	2.01	62	.049
Living Things	28.22%	32.51%	1.02	62	.31
Vehicles	22.63%	19.21%	1.21	62	.23

APPENDIX B

FIGURES

Figure 1

Mean proportion recalled as a function of group, cue, and volume in Experiment 1. The error bars represent ± SE of the mean.

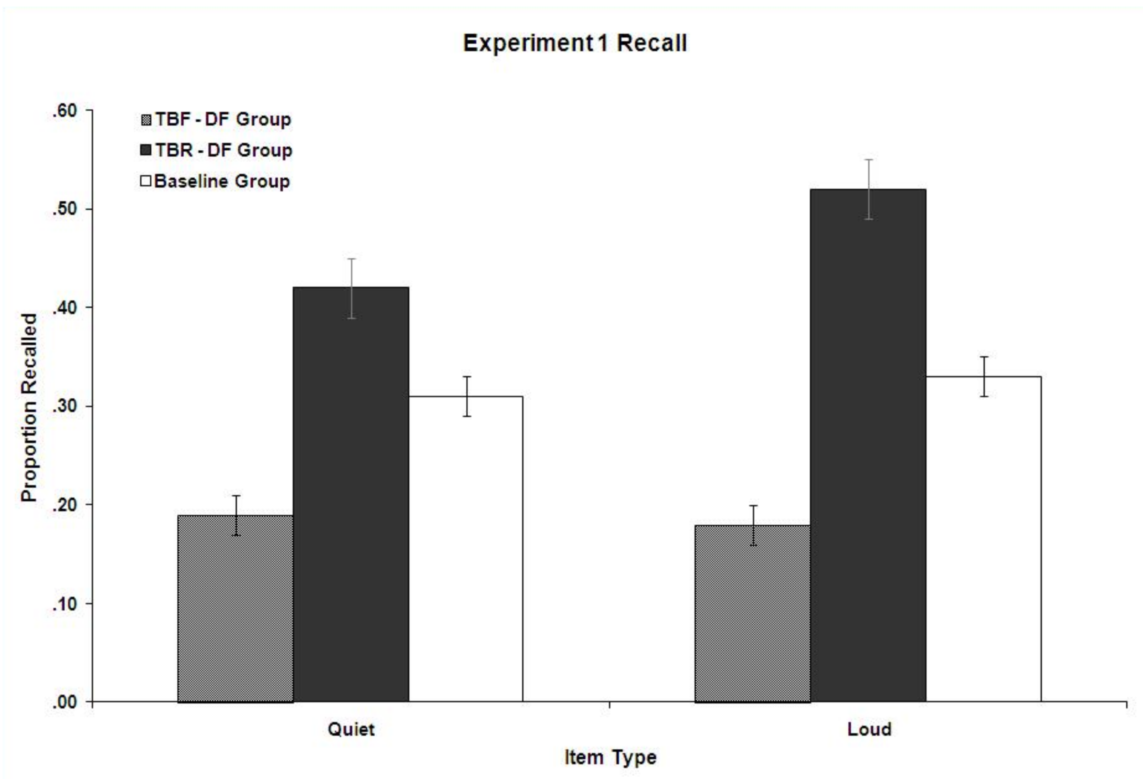


Figure 2

Mean proportion recalled as a function of group and volume in Experiment 2. The error bars represent ± SE of the mean.

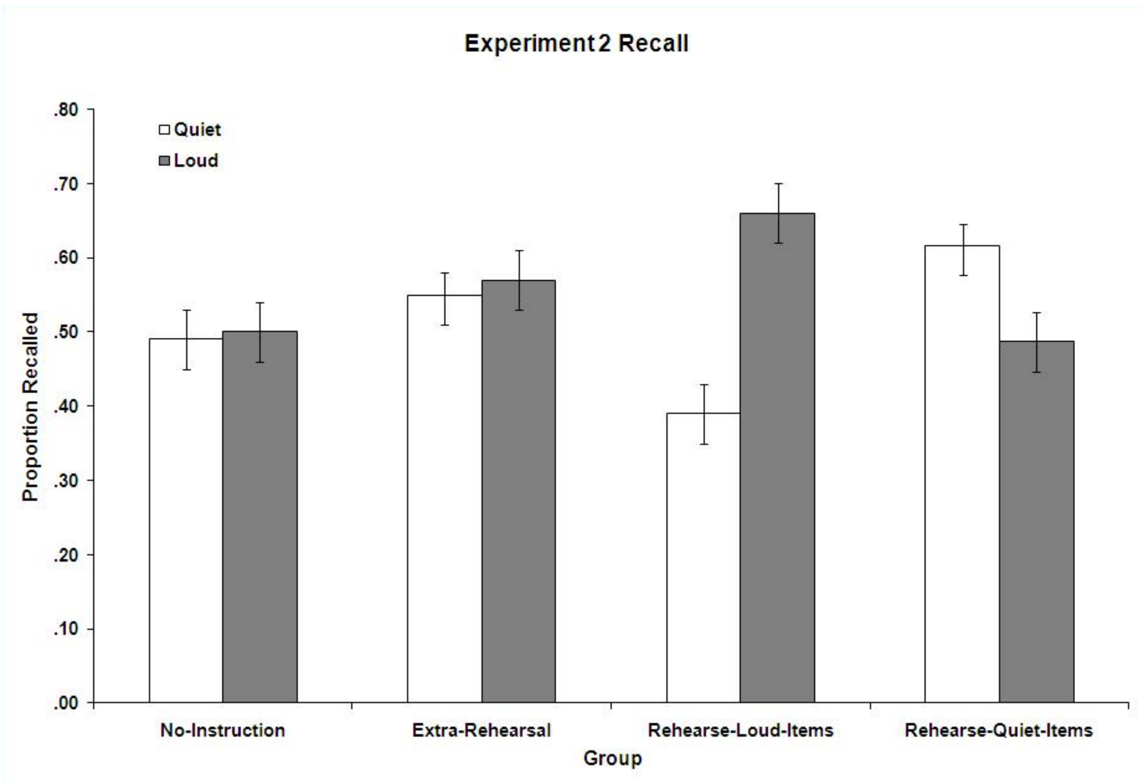


Figure 3

Mean proportion recalled as a function of group, item type, and volume in Experiment 3. The error bars represent ± SE of the mean.

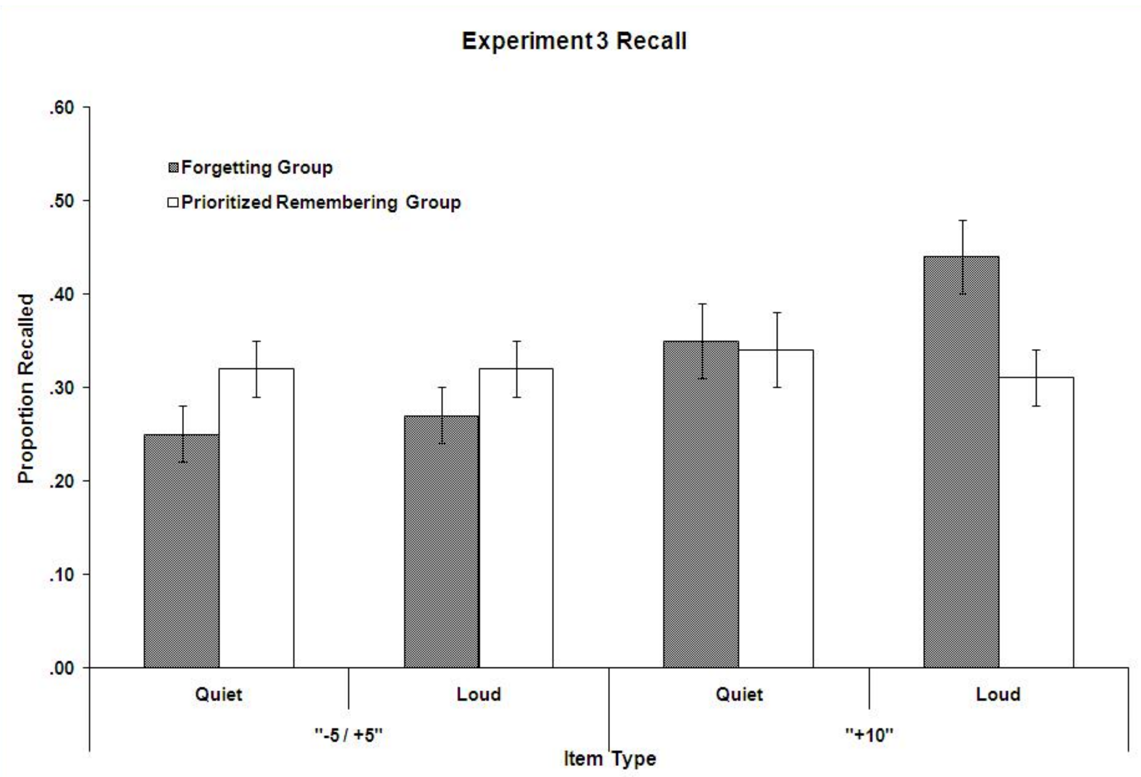


Figure 4

Mean proportion recalled as a function of group, item type, and volume in Experiment 4. The error bars represent ± SE of the mean.

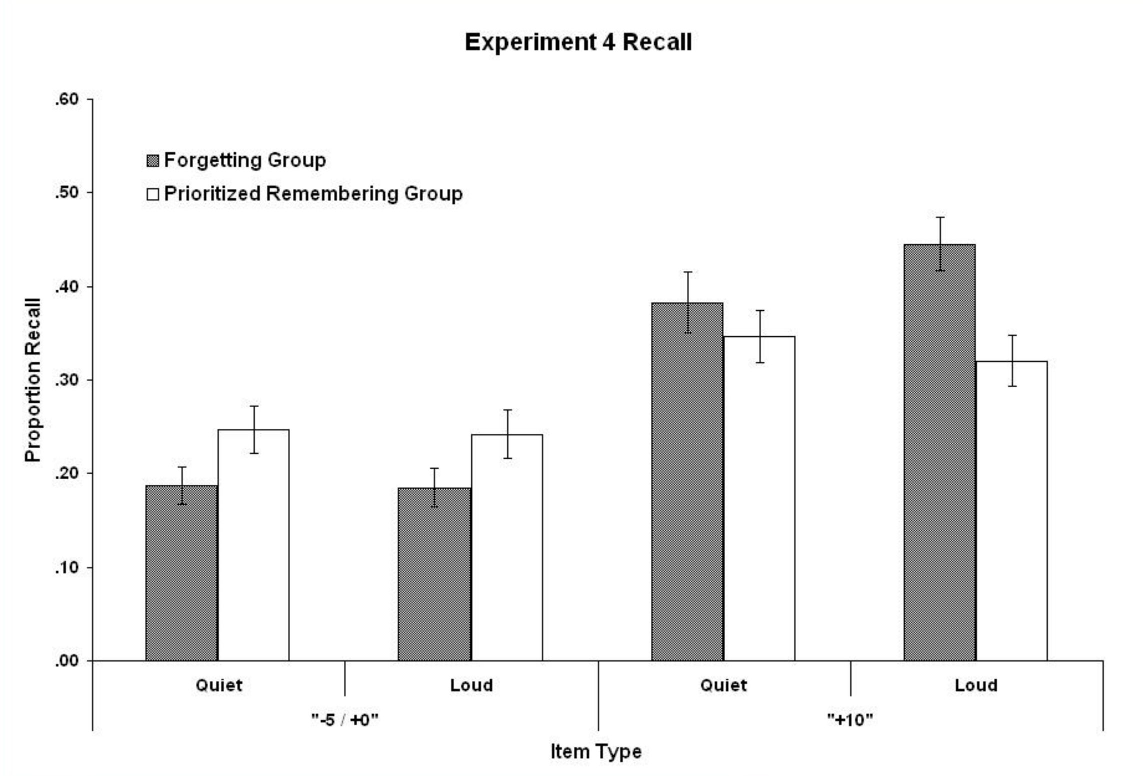


Figure 5

<u>Recall difference between the loud and quiet TBR (or +10) words from Experiment 1, 3, and 4, plotted as a function of reported volume preference in post-experimental questionnaire in forgetting and remembering conditions</u>

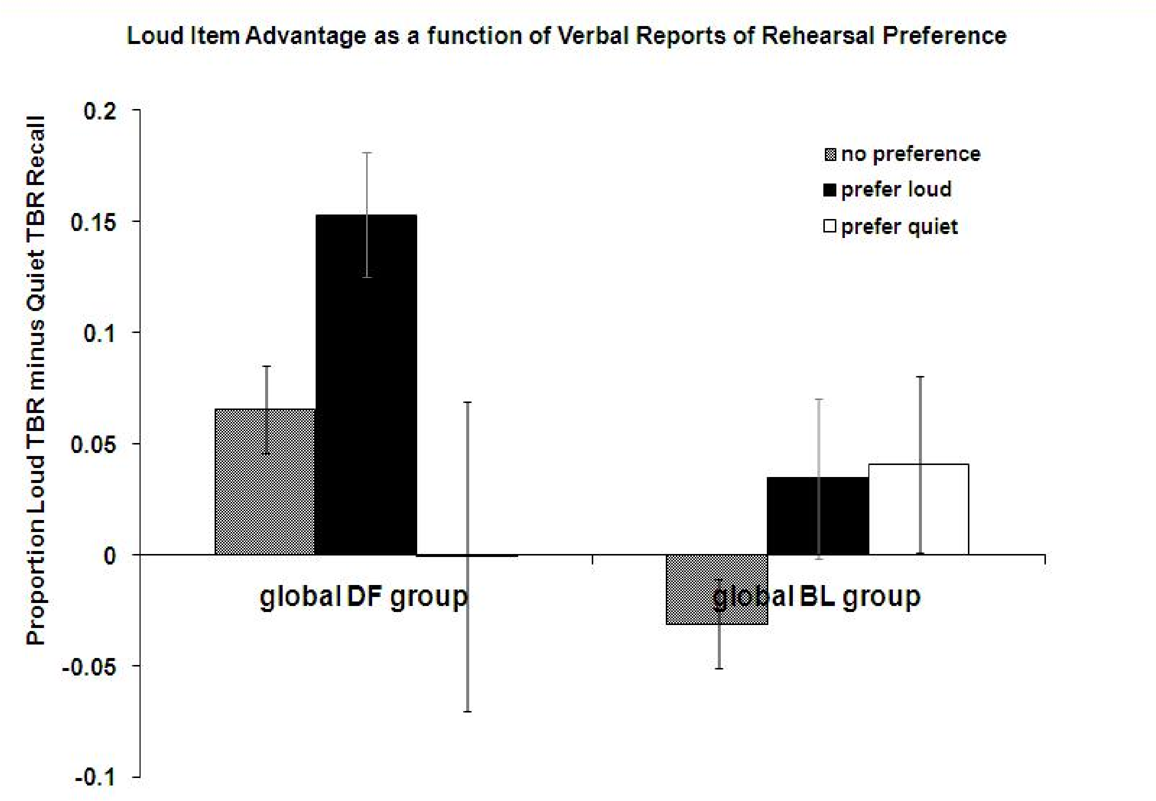


Figure 6

Mean proportion recalled as a function of group, item type, and font type in Experiment 5. The error bars represent ± SE of the mean.

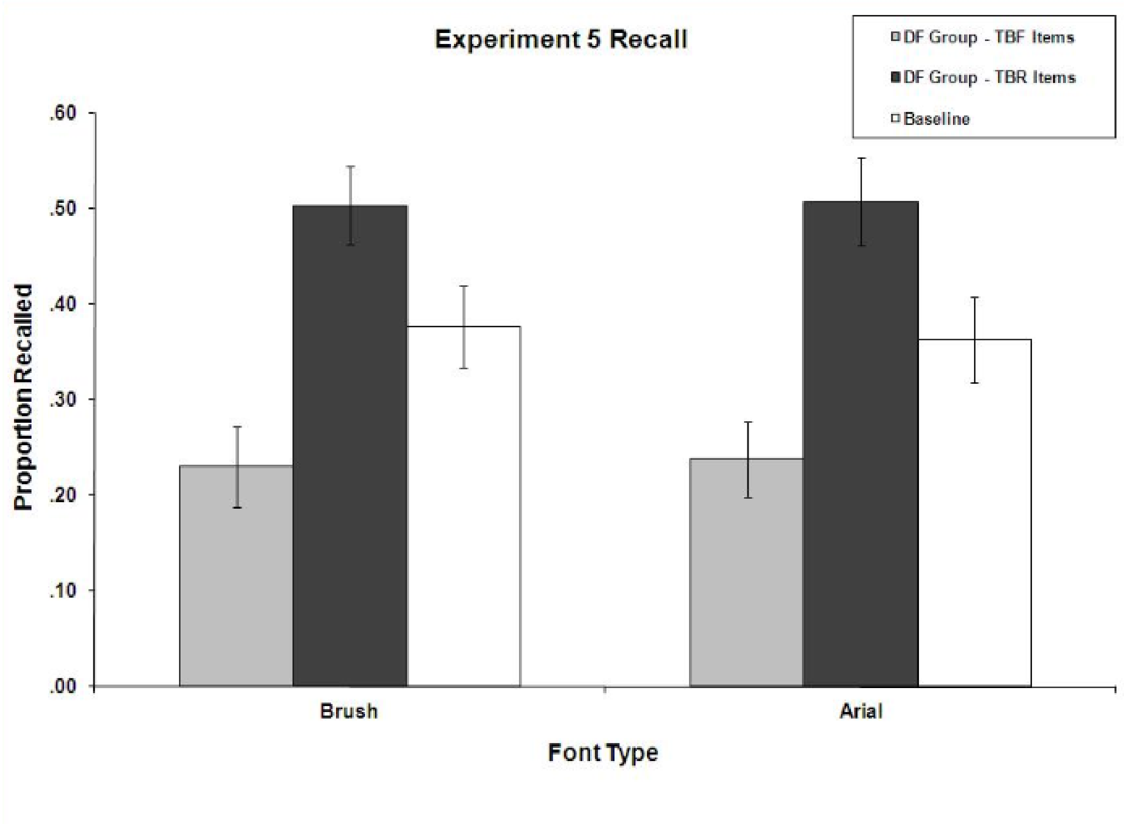


Figure 7

Mean proportion recalled as a function of group and cue in Experiment 6. The error bars represent ± SE of the mean.

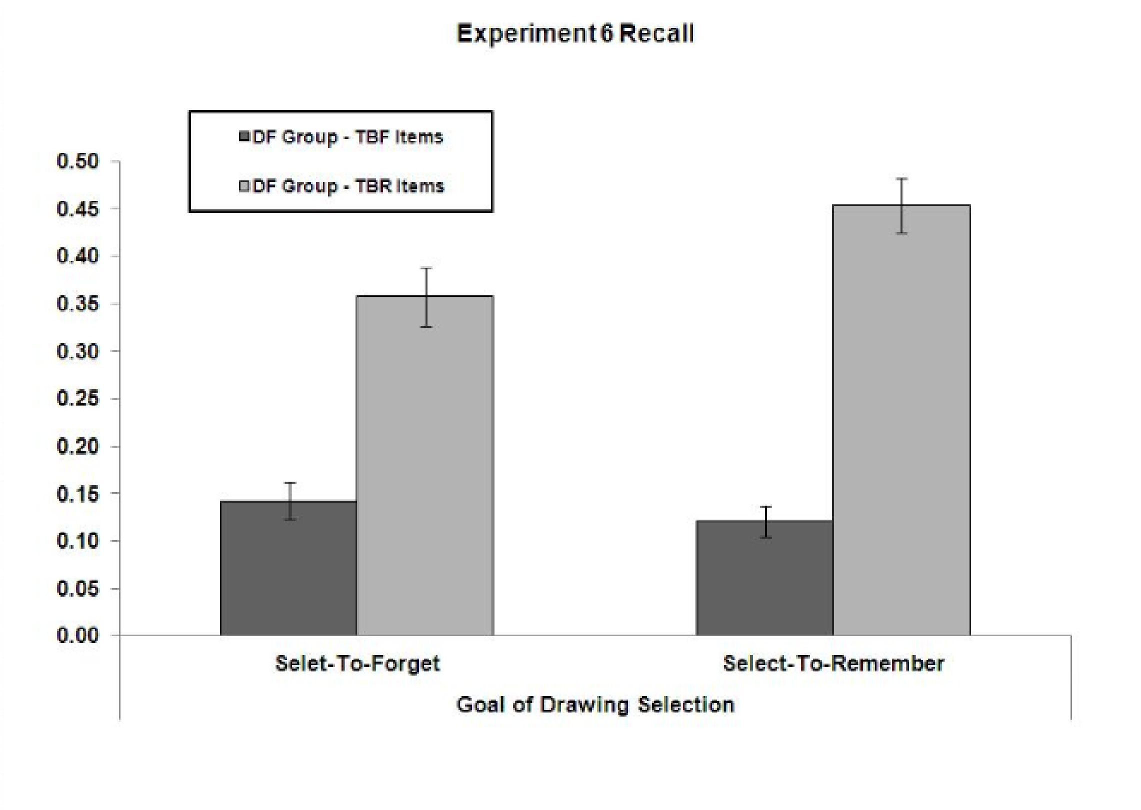
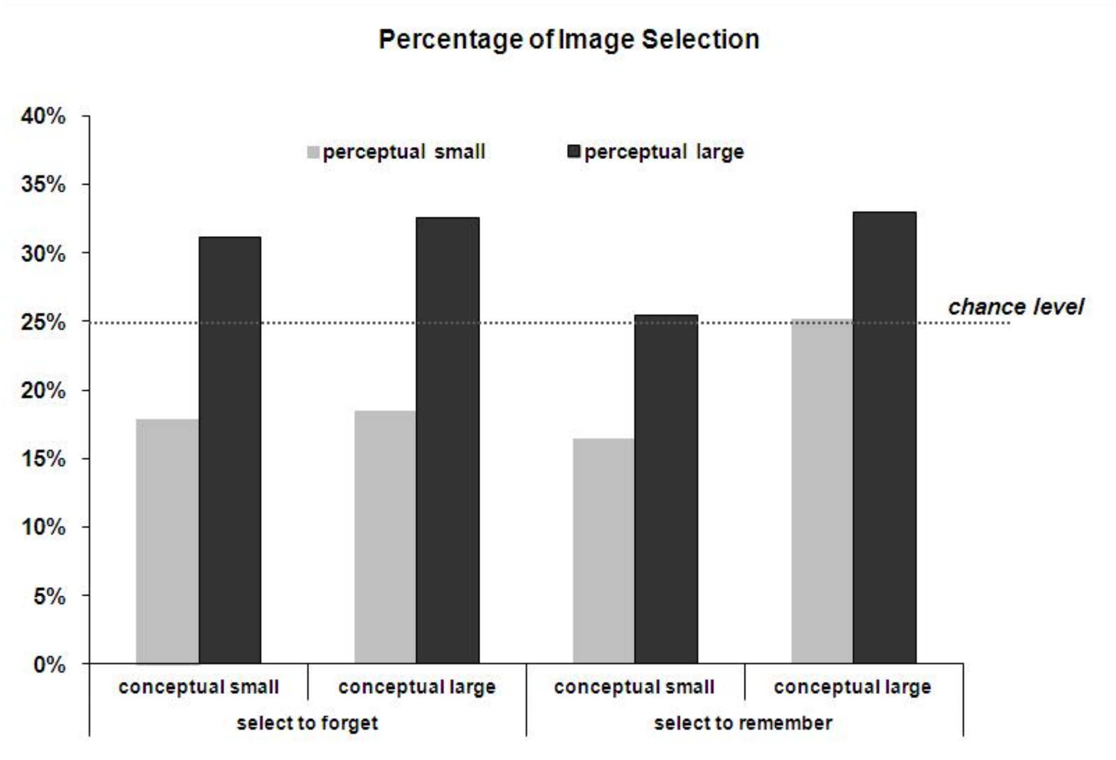


Figure 8

<u>Percentage of images selected as a function of group, perceptual size, and conceptual size.</u>



APPENDIX C

FOOTNOTES

[1] Because 7 of the 64 drawings appeared somewhat small in the 300 x 300 pixel dimension, a larger pixel dimension of 400 x 400 (4.17” x 4.17”) was used to equate these items (i.e., blimp, boat, dinosaur, tank, teeth, tractor, and windmill) to that of the remaining 57 drawings.